J. Nelson Spaeth

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EDITORIAL

WHITHER FEDERAL-LAND GRANT COLLEGE COOPERATION IN FARM FORESTRY?

IT is most difficult to state precisely how and when forestry came into being in the United States. Clearly, interest in forestry arose in many different quarters because of many local influences. It is of interest to note, however, that some of the earliest and indeed some of the most effective support of a forestry program in the United States came from individuals and groups closely associated with agriculture. Apparently, interest in a farm forestry program eventually developed into interest in a general forestry program. As early as 1804, for example, the Massachusetts Society for the Promotion of Agriculture offered prizes for successful forest plantations. In 1865 the report of the Commissioner of Agriculture included an article on "American Forests, Their Destruction and Preservation," by Rev. Frederick Starr, Jr., in which he proposed that each farmer husband his trees or improve their quality or replace judiciously and speedily those removed as to equal one-half acre of forests each year. If this were done, it was estimated that 1,022,038 acres would be planted annually. Then, too, Arbor Day was first celebrated on the plains of Nebraska in 1872. Today Arbor Day is observed in most states.

Naturally enough, much of the early forestry legislation, both state and federal, was designed to encourage tree planting. Between 1865 and 1875 many states enacted laws providing for tax exemption on lands successfully planted, or even for a cash bounty. In 1873 Congress enacted the so-called timber culture laws. The apparent objective of these laws was to encourage tree planting on homesteads. Probably because of the utter failure of these laws to achieve their objectives and also because of the fact that after 1891, when the so-called Forest Reserve Act was passed by Congress, major attention was devoted to the creation and management of national forests and farm forestry problems were more or less lost in the shuffle insofar as federal activity was concerned. To be sure, many of the land grant colleges and universities continued to give more or less attention to farm forestry, but the greatest difficulty was experienced in obtaining adequate financial support for the work. A few years ago the U. S. Forest Service took a new interest in farm forestry. This interest, strongly supported by state agencies, resulted in the passage of the Cooperative Farm Forestry Act in 1938, and an appropriation to carry out the provisions of the act in 1939.

The Cooperative Farm Forestry Act and the policies and procedures developed by the Department of Agriculture to administer the act are of more than passing interest. On one hand they may, to be sure, promote a sound cooperative program of farm forestry; on the other hand, they may not. They may be indicative of a profound change in Department of Agriculture-land grant college relationships; or they may not. They may even promote closer Department of Agriculture-land grant college relationships, but it is more than likely that they will not. They may or may not strengthen the federal government's direct action program. The policies and procedures developed by the Department of Agriculture to administer the act may be the storm center of a prolonged and bitter controversy between the Department of Agriculture and state agencies. It is sincerely to be hoped that this will not occur, but on both western and eastern skies clouds indicating a widespread disturbance are rapidly gathering.

The Farm Forestry Act in the main is orthodox in both form and objectives. Its objects are:

to aid agriculture, increase farm forest income, conserve water resources, increase employment, and in other ways advance the general welfare and improve the living conditions on farms through reforestation and afforestation in the various states and territories. The Secretary of Agriculture is authorized in cooperation with the land grant colleges and universities and state forestry agencies, each within its respective field of activity according to the statutes, if any, of the respective states, wherever such agencies can and will cooperate; or in default of such cooperation to act directly to produce or procure and distribute tree and shrub planting stock, to make investigative inquiries, etc., etc., etc. In both a general and in a very specific way this act seems to imply the usual method of cooperation between the Department of Agriculture and state agencies. However, one discordant note is evident in the act. It provides for direct action by federal agencies in default of cooperation on the part of state agencies. Just why it should be anticipated that any state would default in cooperating with the Department of Agriculture in such a worthy undertaking is not clear. Neither is it clear why a department of the federal government, except in the case of a national emergency, would wish to force a program on a state to which the state agencies objected or were insufficiently interested to cooperate. This provision in the act, however, is of comparatively little moment. The interpretation placed on it by the Farm Forestry Committee of the Department of Agriculture has implications the importance of which, at least to the land grant colleges, transcends that of the entire act.

In interpreting the act as it did, the committee may have felt, although this seems unlikely and improbable, that the Department of Agriculture had received a "mandate" from Congress; perhaps it saw a great opportunity to strengthen the position of the Department of Agriculture in direct action programs in the states; perhaps time will show that the action taken by the Committee was wise and prudent.

The land grant colleges were established in 1862, but for many years prior to this date it was recognized that institutions of higher learning were necessary in the vast and rapidly expanding West. Strangely enough, when the Morrill bill was first passed by both Houses, it was vetoed by President Buchanan because of the objections of the South to federal aid. In 1862 the bill finally became law and the land grant colleges were born. Was it design or change that impelled Congress to create the U. S. Department of Agriculture and the land grant colleges the same year?

However this may be, it seems clear that during the 77 years that elapsed since 1862, the joint responsibility of the federal government and the several states to serve the agricultural industry and the farm people of the nation has been widely recognized. Furthermore, during these 77 years a magnificent record has been achieved in agricultural education, research, and extension through federal-state cooperation. This record has received world-wide approbation.

During the past few years, the federal government has shown an increasing tendency to set up new programs on top or along side of the federal-state cooperative program. The policy and procedure developed by the Department of Agriculture to administer the Cooperative Farm Forestry Act are regarded by many of the land grant colleges as one more addition to the already too long list of programs undermining the federal-state cooperative approach, and unfortunately a critical study of them seems to give some support for this point of view.

If the administration of the Cooperative Farm Forestry Act results in a serious federal-state controversy, it will be a sad reflection on the administrative skill of officials in both the U. S. Department of Agriculture and in the land grant colleges. The Cooperative Farm Forestry Act has gotten off to a bad start, but no serious damage has been done so far, nor is it too late to make the necessary changes that will permit it to function smoothly. Because of the fact that at least several agencies in the U. S. Department of Agriculture and at least two agencies in most states are involved in carrying out the provisions of the act, some misunderstanding and at times even some friction may arise. However, if the Cooperative Farm Forestry Act is wisely and judiciously administered, it may indeed serve as an example of how complex federal-state cooperation may be and still serve the agricultural industry effectively and smoothly. Foresters in both federal and state agencies influenced the wording of the Cooperative Farm Forestry Act; foresters in both agencies supported its passage; foresters in both agencies must now cooperate to make it effective. If the act fails to accomplish its high objective, then foresters will have signally failed.

DEDICATION OF MEMORIAL TABLET TO HENRY E. HARDTNER

By H. H. CHAPMAN
Yale University

On the afternoon of April 27, 1939, all business was suspended in Urania, La. The school and mill were closed, and the entire population gathered in the memorial park to dedicate the bronze tablet which was the gift of the Society of American Foresters, the alumni of the Yale School of Forestry, and the Hardtner family.[1]

THE first contact of Yale with Henry Hardtner was in 1917. For ten years previously this senior spring field work had been migrating from company to company in the Gulf States, finding everywhere the utmost courtesy and hospitality, but no interest whatever in forestry.

In 1915, Mr. Hardtner had taken what were practically the first steps instituted in the South in a program of forest renewal looking towards a sustained yield for this property, by fencing a tract of 1,500 acres against hogs in order to reproduce longleaf pine, installing a system of fire protection through the employment of local men as district fire wardens, and by cutting to a diameter limit intended to preserve an adequate growing stock for subsequent cutting. On request, the school in 1917 was granted the privilege of locating its field work at Urania, and in 1920 Mr. Hardtner gave the Yale School of Forestry the use of a permanent camp, which has been occupied continuously each spring since that date.

In this way the acquaintance of the Yale Forestry School faculty with Henry Hardtner has been long and fruitful. His interest in forestry was not confined to immediate profits but sprang from a deep and genuine concern for what he termed his "baby pines," an attitude inherited and inspired by his German ancestry through his father who had come to America from the region of the Black Forest. In this respect he differed from practically all other southern lumbermen of the period. He was the pioneer in measures taken on his own lands to secure from seed new crops of pine. His success in these initial experiments served as the incentive for several other southern operators, and actually marked the beginning of forestry practice in the Gulf States.

Mr. Hardtner in public life inspired the creation of the first southern conservation commission, the first tax contract law for growing new crops of timber, and the first severance tax law, the purpose of which was to raise funds for reforestation by the State of Louisiana. The first substation of the Southern Forest Experiment Station was established at Urania, and the permanent sample plots established here by S. T. Dana were the first in the South.

But here at Urania Henry Hardtner will be remembered longest as a friend, always sympathetic, ready to listen, and to aid those in trouble. One incident was characteristic of this great man. One day a forlorn individual appeared at his house asking for a meal. Mr. Hardtner in conversation with him discovered that this hobo had once been a forester in the employ of the King of Saxony. Franz von Lilienthal remained from that day at Urania, cared for by Mr. Hardtner and is buried in the small cemetery near town.

Henry Hardtner had three qualities which made him outstanding in forestry; these were vision, courage, and initiative. He sought information from such men as W. W. Ashe and Wilbur Mattoon, and proceeded to put their suggestions into practice. As more was learned about the requirements for securing successful reproduction and growth of such species as longleaf pine, he did not hesitate to adopt new methods.[2]

Henry Hardtner needs no formal tablet to commemorate him. His true memorial is in the hearts of his friends.

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[1]This park, the gift of Mr. and Mrs. Quintin T. Hardtner, contains a log cabin museum, an artificial pond, and a playground for children. For description of tablet see S. A. F. Affairs, Jan., 1938, page 12.

[2]The tale of a root—the root of a tale, or root hog or die. Jour. Forestry 33:351-360, 1935.

Henry E. Hardtner Memorial

DEDICATION ADDRESS TO HENRY E. HARDTNER

By WILBUR R. MATTOON
U. S. Forest Service

WE who are assembled here today come from many different places and have diverse life interests and problems, but we come with but a single thought and a single purpose, namely, each to do our little part in memorializing the life of a great man who will go down in history as a pioneer and an inspiring leader in forestry in the southern United States.

Just as occasionally a tree springs in an opening in the forest and establishes its roots in deep fertile soil beside a stream and grows to tower above all its associates, so it happens occasionally with men. Today we pay homage and are here to dedicate a memorial to the life and achievements of such a man—Henry Ernest Hardtner.

Born of German parentage in Pineville, La., on September 10, 1870, his father a native of Wurttemberg, Henry Hardtner grew up with an inherent appreciation and love of trees. This inherited trait and his early education were stimulated by the environment of a forest region of fast-growing valuable pines and hardwoods, a region which to this day stirs the admiration and envy of forest-minded people everywhere. For a decade and more popularly regarded as a dreamer, he lived to influence thousands of people and lay the foundation and much of the structure of what we see today in the increasing protection and conservation of our forest resources. Passing from us on August 7, 1935, at least two-thirds of his life was spent in what can appropriately be called the dark ages of forestry. He touched the lives of thousands, as witness the visit in 1917 of Bolling Arthur Johnson, editor of a then prominent lumber journal, who came to Urania a skeptic, but returned to his office in Chicago to wield a mighty pen for the fair treatment of our forests. The forestry at Bogalusa in a large measure resulted from the inspiration obtained from visits of officials to Urania after Henry Hardtner had successfully demonstrated the method of securing young longleaf by fencing against hogs.

In fire prevention, he was a pioneer. Practically all southern forest lands were promiscuously burned over every year or two. By 1913, he had an organized fire protection system on his lands and was building up local public sentiment against fires so that his lands became well protected when the balance of the state and the people of all the deep South were of a common mind that fires were truly as inevitable as the rising sun and fully as necessary to the life of man. In a letter written to the speaker dated January 26, 1914, he states:

"We have had a month's dry spell since you were here and the entire forest country north of Red River from Columbia to Alexandria has burned over or is at present burning. The exception is 150,000 acres contiguous to Urania which includes the H. Hardtner Forest. We have had eight fires—losing only about 40 acres. Our wardens are watchful."

Henry Hardtner was the author of various forestry legislation, including a law by which his state placed a fixed valuation of one dollar an acre for purpose of taxation, over a period of 40 years, on lands devoted to forest production. Based on this provision, he figured out the cost of growing timber by planting stands on denuded lands. As the results largely of his efforts, Louisiana early established a Conservation Commission, and in 1908 Governor Sanders appointed him chairman of the first session of the commission—incidentally the first of its kind in the Gulf region of the South. Another law established a severance tax on timber as cut whose purpose was to provide funds for state forestry work.

In order better to reflect the ideas of Henry Hardtner nearly 30 years ago, permit me to quote from an article by him published in the January 1910 issue of the *American Forests* magazine:

"The conservation of natural resources is a question of great importance and is engaging the attention of many of the foremost citizens of our country who are now endeavoring to formulate such plans as will aim to prevent the destruction of these resources.

"The forests of the South, which are chiefly in the hands of private owners, are being handled carelessly, criminally, and with the idea of getting every possible penny out of them regardless of their future usefulness to mankind.

"Therefore, the preservation of our forests is the most important question that we have to deal with at this time, and we cannot wait years before we attempt to solve the problem. No doubt the national government will ere long offer substantial assistance to the states in the difficult and costly work of reforestation, but the states cannot

afford to wait for assistance; they must go to work at once and handle the question honestly, intelligently, conservatively, and successfully.

"The future of the South is bound up in forest preservation with its accompanying protection to watersheds, power streams and the wood-working industries; not only in the protection of the watersheds, which will some day furnish the power to the great majority of the manufacturing establishments but in the prosperous continuance of industries depending upon forest products.

"It does not take a wise man to answer the question quickly. Protect your remaining forests and commence at once the reforestation of your denuded areas. Enact stringent forestry laws that will protect the state and Nation."

Among the ideas that Henry Hardtner advanced and practiced far ahead of his time in conducting a lumber business was that of forest growth. The universal custom of lumber concerns was to acquire and hold old-growth timber for far-ahead operations. In the decade of 1910-1920, Henry Hardtner was thinking and acquiring young growth timber for his supply in future operations when his old-growth would be gone. This is a far cheaper method, he rightfully maintained, than to buy and hold old timber over a long period of years. His operations and those of others later, fully substantiated the soundness of his pioneer ideas on this practice.

Henry Hardtner always showed a keen desire by his observations and by his reading to learn the principles of forest conservation in woods management. Moreover, he was practically the first lumberman to put these essential points into practice. From an original investment of $1,000 this keen observer and shrewd operator built up a holding of 90,000 acres and a going timber business.

He was a forester in the truest sense with an open mind always ready to learn the facts of forest development. His contact with trained foresters dates from 1909 in the visit of the late W. W. Ashe of the U. S. Forest Service during which factors influencing forest growth were especially considered. At this point, with your permission and indulgence, the speaker might add some sidelights by including a brief reference to his visit to Urania on December 9 and 10, 1913, that of the second forester to visit Henry Hardtner. The visit resulted from Mr. Hardtner's request by letter for the cooperation of the U. S. Forest Service in establishing some forestry experiments on his lands. The preliminary plan which the speaker drew up at the time of his visit outlined experiments in thinning and in protection from fire of selected typical areas in stands of loblolly, shortleaf, and longleaf pines. The resulting sample plots, established one year later by Samuel T. Dana of the Forest Service, are the earliest of their kind to be established in all of the Gulf region or the South.

The two days of leisurely travel by the speaker through the woods in observing and discussing trees and forest problems, with the genial "Uncle Henry," as he later came to be affectionately and widely known among foresters, was a most delightful experience. On many occasions since then, it has been my rare pleasure, along with that of literally thousands of other visitors, to share with the genial forester the lure of his woods.

In 1917 Henry Hardtner became the host of the Yale School of Forestry for the spring field training work of the senior class, and this relation has continued to the present time. Thus the two lines of research and education were strong points in his range of interests and achievements. He was a prolific writer and almost magically had at his finger tips a wealth of basic material and current information. His activities in forestry always carried a two-fold interest, namely, public or political and private or individual. He was liberal, genial, and cooperative with people all the way from his neighbors and country people to those in high places in state or nation.

In a large and enduring way, Henry Hardtner pointed the course for lumbermen to manage their timber so as to operate it on a sustained yield basis. He showed by actual practice on a large scale on his own lands how to manage young growth stands, how to deal with the problem of fire and forests, how to get longleaf pines to come back naturally, and how to proceed in cutting timber so as to get natural seeding and normal growth and thus how to maintain a merchantable timber crop in perpetuity.

In the words of John Burroughs, a great man of the out-of-doors, "Time must be lived to become sacred." To Henry Hardtner, we who are here assembled and many others who are with us in spirit today dedicate this memorial in lasting memory of his high and far-reaching achievements in the advancement of forest appreciation and sound forest management.

IN MEMORIAM—HENRY E. HARDTNER

By R. K. WINTERS
Southern Forest Experiment Station

WE are gathered here this afternoon to dedicate a memorial of bronze and stone to a pioneer in forestry in the South, to a public-spirited citizen, and to a close personal friend of many of you. While we are doing this, it is very fitting, I believe, that we dedicate ourselves as living memorials to those ideals for which Henry E. Hardtner stood during his lifetime.

In my fanciful moments I sometimes beguile the time by seeing myself not as an individual but as a bundle of borrowings from the people great and small who have touched my life. Thus I am not myself alone, but a composite person made up of traits and characteristics borrowed during my childhood from my parents, my school teachers, and later from my associates in the business and social worlds. From some one of my superiors, I may have learned many a trick of my trade, and from another I may have borrowed a mannerism, a habit of speaking, or even a habit of thinking.

I suppose that each of us, moved by a similar fancy, could also see himself as a bundle of borrowings from his associates. To some of you, Henry E. Hardtner was an employer, to others a fellow citizen, to others a neighbor, and to still others a friend. Over a long period of years, he touched many of your lives in a real and intimate way. I cannot know the exact way in which he contributed to your lives individually; you and God alone know that now. Let each of us, however, at this solemn dedication ceremony think of the finest contribution that Henry E. Hardtner has made to our lives, and in this quiet afternoon, with that thought uppermost in each of our minds, let us unite in dedicating our lives to those high ideals with which the name of Henry E. Hardtner will be associated forever.

At the conclusion of the program, the memorial tablet was presented and unveiled. Mr. Quintin T. Hardtner, brother of the late Henry Hardtner and president of the Urania Lumber Company, made a brief speech of acceptance referring to Mr. Hardtner's troubles with the then existing state administration, and in closing read Mr. Hardtner's last letter,[3] which had been mailed for copying, on the day before his death and had been unearthed only a few days before the dedication. The letter, written August 6, 1935, is as follows:

"During the year 1936 we will cut our last stand of virgin timber in Winn Parish, after nearly forty years operation, but that does not mean that we are going out of business. Our potential supply of timber today (timber that we are growing) is greater than the original forest yielded; therefore, if we are permitted to continue our policy of reforestation we will have a perpetual operation. We still have a small quantity of virgin timber in La Salle and Caldwell, but at present we are buying on the truck enough timber to operate our mill. We are employing more labor today than ever before, some four hundred, and I am safe in saying that fully two thousand people get a living through our enterprises.

"In lumbering, fully ninety per cent of the manufactured value of the products delivered to the trade goes for labor, timber, and supplies; a kind of partnership between labor and capital. A company may have title in their name to a block of timber, but labor has an interest in every tree, and now after forty years saw milling at Urania and the end of our original forests in sight you ask about our plans for the future.

"We will simply remodel and rebuild our mill to handle profitably the smaller sized logs that we will have to utilize. We will put up a rayon mill, a paper plant, a timber treating plant, or such a plant as will furnish timber products that the trade demands. We are not yet sure as to future operations. Taxation is the monster we must face. We can move our plant to Caldwell Parish and get a thirty mill tax rate, or Ouachita on a twenty mill tax rate, as against fifty mills or more in La Salle or Winn.

"We feel as if our work should be compared to

[3]Henry Hardtner was killed on August 7, 1935, in an automobile collision while proceeding to Baton Rouge to defend a case for "back taxes" brought by the late Governor Huey Long against the Urania Lumber Company. This attack on the integrity and policies of the company was the occasion for the writing of this—Mr. Hardtner's last letter.

an illustration of duty and service as recorded in the greatest of all books—how a man called his servants together and gave them talents, and told them that in time he would demand an accounting. The story is familiar to all, and has not Urania rendered a faithful accounting? Master, here is more timber on these lands than we cut off. We cut only timber that was ripe and opened up space and opportunity for the young and suppressed trees to thrive and seed trees were left to reseed the open spaces. Should not Urania face a crown instead of a big stick?

"The business which I founded at Urania in 1896 is in safe hands."

SOIL-COLLECTING TRENCHES AS SUBSTITUTES FOR TEMPORARY CHECK DAMS IN REFORESTING GULLIES

By H. G. MEGINNIS
Southern Forest Experiment Station

The reforesting of gullies is a difficult and relatively expensive job at best. The trials of soil-collecting trenches as substitutes for temporary check dams in reforesting gullies has not yet progressed sufficiently to warrant final conclusions, but the results obtained so far indicate that the method may find considerable use on erosion control projects. Furthermore, it is likely that additional study of the method will result in improvements and modifications to broaden its sphere of usefulness.

COMMON procedure in reforesting gullies is to construct small temporary check dams in the drainage channels to collect soil outwash and to build up deposits on which trees can gain a foothold. The sediments caught behind dams remain moist and well aerated, and, even when derived from raw subsoil materials, usually provide relatively productive growing sites. Although check dams are a useful mechanical aid in establishing trees on sites that are very unfavorable for plant growth, these structures cannot be used advantageously in certain types of gullies (Fig. 1). In the loessal uplands and adjoining upper Coastal Plain province in Mississippi, for example, some of the large laterally extended washes peculiar to this region are difficult to reforest economically by means of check dams. Even when many dams have been built in the channel of such gullies and have caught capacity loads of soil, they may still provide growing sites for only a few trees and may leave a major portion of the gullied area unimproved and hence incapable of supporting tree growth. When such is the case, the trees must be planted too sparsely to provide effective cover or to insure a degree of control commensurate with the cost. Furthermore, gullies of this type, in spite of their large expanse and considerable depth, often do not provide suitable locations for dams, owing to the great width of the channels and to the low or nearly obliterated ridge-divides into which the dams must be abutted. The latter difficulty is also encountered on severely sheet-washed or galled slopes of compact soil, on which erosion has spread over extensive areas but has not carved out drainage channels of appreciable depth.

Trenches excavated in the hard residual soil of a gully bottom will collect plantable depths of soil outwash comparable to those caught by check dams. These structures have been tried out on a limited scale by the Southern Forest Experiment Station in connection with gully-control studies near Holly Springs, Marshall County, Miss., and under certain conditions they appear to have promise as an alternative to check dams in improving the growing site for trees and other plants. Facts which indicate that the method is feasible and will prove effective in this locality are: (1) Many of the gullies are entrenched in very compact subsoils that will withstand considerable scouring from run-off without deepening at an appreciable rate; (2) these raw subsoil materials, quite unproductive in situ, are inherently fertile and become much more productive when transported by run-off and deposited as alluvial sediments; and (3) establishment of shortleaf and loblolly pine seedlings in hard, gullied subsoils by planting them in ordinary-sized planting holes filled with fertile topsoil has been eminently successful (Fig. 2).

So far as is known, soil-collecting trenches or

Fig. 1.—Types of gullies prevalent in the loessal uplands and upper Coastal Plain that are difficult to reforest using orthodox check-dam, bank-reduction methods. *Above,* a huge amphitheatre-shaped wash resulting from a leveling of drainage channels on resistant substrata, with subsequent removal of intervening ridges and lateral expansion of the perimeter; frost action is a major factor in the growth and formation of such gullies. *Below,* a denuded slope resulting from sheet erosion and shoestring gullying of a compact subsoil—a type of erosion characterized by few or quite shallow drainage lines.

Fig. 2.—*Above*, a soil-collecting trench dug in the refractory clay-loam subsoil of a shallow but steeply pitched gully channel. The potholes above the trench have formed by the slow wearing away of this erosion-resistant material. The trench is partly filled with sediments washed from upslope. These soil deposits, although derived from subsoil materials which are infertile in situ, furnish good growing sites for trees. *Below*, 3-year-old shortleaf pines successfully established on a rocklike, clay-loam subsoil. The seedlings, 1-year-old nursery-grown trees, were planted in holes filled with fertile surface soil.

Fig. 3.—One-year-old loblolly pine growing on the soil outwash caught by a trench, the areal boundaries of which are marked by the stakes. The trench, which was dug three years previously to a depth of 18 inches in the hard floor of the gully, still retains a soil catch over 1 foot deep.

pits have not been used in this country as a gully-control measure, although terrace-trench systems designed chiefly to store run-off and conserve moisture have been widely used as an aid to restoring a plant cover on denuded or impoverished slopes. In Italy, pits or *buche* are sometimes used as an alternative method to the well-known *gradoni* system of afforesting denuded mountain slopes.[1] In tropical countries, trenches or pits have also been used to collect soil or leaf litter, thereby improving the growing site for tea, rubber, and other tree crops.[2]

At Holly Springs in 1935 a series of 20 short trenches was constructed[3] in two moderately large gullies as a preliminary test of the performance of these structures. The trenches, which were simple, vertical-walled, rectangular pits 18 inches wide, were excavated to a depth of about 18 inches in the consolidated clay loam subsoils comprising the floor of the gully channels, the excavated material being piled downslope. The trenches were laid out at right-angles to and extending across the drainage channels, and were located where check dams would normally have been constructed. The channels, which were of the narrow v-profile type, had scouring gradients of about 3 to 10 percent.

Within a few months, all the trenches had filled with soil outwash, most of which was the excavated material. Aside from casual observations, no particular attention was paid these structures until two years later (the spring of 1937), when an inspection revealed that all the trenches were intact and contained outwash soils to plantable depths. These deposits were planted in March, using 1-year-old nursery seedlings of black locust and loblolly pine—the site being particularly well suited to the latter but somewhat too sandy for black locust. These plantings, when examined a year later (1938), were all alive, and the pines had made excellent growth (Fig. 3). Growth of the black locust was rather mediocre, as is frequently the case when this species is planted on similar sites.

The depth of the soil deposits in the trenches when examined in 1938 indicated that the floor of the gully had deepened 6 to 10 inches during the 3-year period. The trenches, however, contained 8 to 12 inches of sedimentary deposits, which was sufficient to afford pines a satisfactory foothold. Had the trees been planted during the first year rather than two years later, the rate of channel degradation would doubtless have been reduced materially, inasmuch as the southern pines often furnish considerable site protection by the second or third year, and by copious needle fall encourage the deposition of soil beneath the crowns.

During 1938 a number of soil-collecting trenches of differing design, some of which are shown in Figure 4, were excavated in several types of gullies to obtain further information on the feasibility and potential uses of these structures. Although additional trials are needed, preliminary observations indicate that, in northern Mississippi and comparable localities, trenches may be employed effectively as site-

[1]Sinha, J. N. Reafforestation in Italy. Indian Forester 64:269-276. 1938.

[2]Till, F. D. Some practical notes on the prevention of soil erosion upon estates. Tropical Agriculturist 66:252-256. 1926. Holland, T. H. Soil erosion and cover crops. Ibid. 66:248-252. 1926. Bertrand, H. W. R. Conservation of soil and water. Ibid. 74:67. 1930.

[3]These trial structures were suggested by Norman E. Hawes, at that time forestry technician with the Southern Forest Experiment Station.

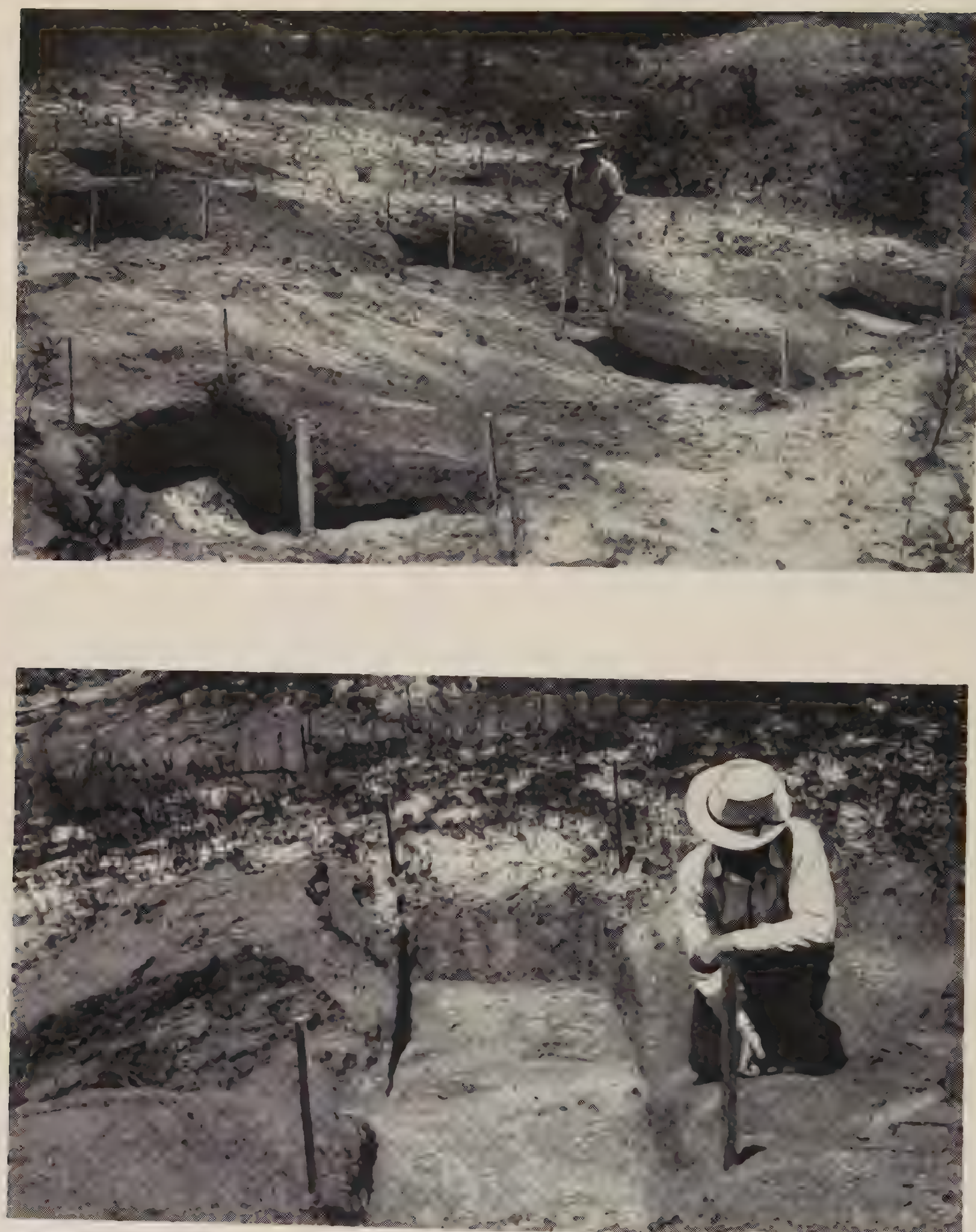

Fig. 4.—Soil-collecting trenches dug in the compact soils of a severely eroded hillside where the absence of drainage channels precludes use of check dams. *Above*, a series of newly constructed trenches with the excavated earth spread out immediately downslope from each structure. *Below*, detailed view of one of the trenches about six weeks after it was excavated. The trench dug to a depth of two feet is almost full of sedimentary deposits washed principally from material excavated from the trenches upslope. Note that run-off has carved a channel through the loose soil piled downslope from the trench.

improvement measures in the types of gullies referred to above, in which it is difficult to build temporary check dams. Furthermore, it appears that trenches can be substituted successfully for dams in those locations where the gully has developed in consolidated subsoils but where the lack of brush or other raw materials makes it difficult or uneconomical to construct check dams. Trenches, unlike dams, require no materials, and can be constructed by unskilled labor with little supervision. This and the fact that the soil excavated from the trenches provides suitable fill material, whereas extra labor is required to reduce gully banks in order to furnish a quick catch of soil for dams, are factors which may recommend the trenching method for use on certain projects.

Often trenches cannot be dug in the more refractory subsoils during the normally dry months of summer and early fall, owing to the fact that these soils become rocklike when thoroughly desiccated; when moist, however, they can be dug with little difficulty. Although mechanical equipment has not been used to excavate the trenches, it may prove more feasible and economical to use horse-drawn plows and drag scrapers or even small power graders in many of the broader washes.

Although reliable cost data are lacking, the indications are that trenches are more time-consuming to build than the more simple types of brush dams, although less so than other common types of brush structures. Thus in channels 3 to 10 feet in width, about 2 man-hours of labor per unit were required to construct a series of 24 soil-collecting trenches; although this is approximately twice as much labor as is required to construct pole-frame brush dams[4] in similar situations, to build certain types of brush dams would require two or three times as much labor.

Before soil-collecting trenches can be recommended widely or employed extensively on gully-control projects in the southern states, a number of points need investigation. One such question is, will trees of the species employed in gully plantings grow as rapidly on soil-filled trenched areas as on similar deposits caught behind check dams? As previously indicated, rather extensive experience in planting shortleaf and loblolly pines in small, soil-filled planting holes prompts the belief that the large volumes of soil provided by trenches will afford relatively good growing sites for these two species. These sites, however, may be a little less productive than soil deposits caught by check dams, since the latter represent an accretion to the gully floor and provide maximum opportunity for tree roots to spread through loose, well-aerated soil without penetrating refractory subsoils. Other problems that require investigation are the effect of subsoil type, channel gradient, and quantity of run-off discharge on the effective life and performance of these structures. Furthermore, tests of various types of trenches will doubtless be required in order to provide a basis for designing structures of maximum usefulness and ease of construction. Nevertheless, although additional research is needed, soil-collecting trenches offer sufficient promise as a site-improvement measure to warrant more extensive trial on gully-control projects.

[4]See: The pole-frame brush dam—a low-cost, effective mechanical aid in reforesting gullied land. Occasional Paper No. 76. Southern Forest Experiment Station. 1938.

ACCORDING to the latest report of the Department of Forests, the state forests of Latvia have a gross area of 4,287,000 acres, of which only 3,419,000 acres are timbered. This is slightly more than the forest area of Massachusetts. The Forest Department employs to administer this area a central office staff of 293 and a field force of 3,344, beside numerous seasonal employes. Laborers are not included in these figures.

A "TWO-WAY CHANNEL" IN PLANNING

By BUSHROD W. ALLIN
Bureau of Agricultural Economics

County planning is one of the newest developments in the broad field of land use planning. It differs, however, from other planning practices in that those most directly affected by the plans actually participate in their formulation. County planning is now being done in many states. The following article describes not only the method but the broad authority under which it is done.

RECENTLY, Extension Forester K. E. Barraclough[1] observed in the JOURNAL OF FORESTRY that "County land use committees may make some very interesting recommendations after they study the facts."

A specific instance of the "very interesting recommendations" that Mr. Barraclough expected to emerge from county land use planning meetings is available in an Ohio county. In this county, a group of farm men and women sat down with a handful of state and U. S. Department of Agriculture officials, turned their attention to the Forest Service, and adopted a number of definite suggestions aimed at meeting some of the needs of the county.

Among the suggestions were:

Inasmuch as the federal Forest Service nursery in the county is not being operated at capacity, consideration should be given to operating it more fully in order to supply seedlings for reforestation. Furthermore it was suggested that the agricultural conservation program should pay $5 per acre for planting the trees.

A method should be worked out by the A.A.A., W.P.A., S.C.S., F.S.A., and Forest Service whereby unemployed or part-time agricultural workers could be used to reforest worn-out agricultural lands.

The federal Forest Service and State Division of Forestry should "cooperate with the S.C.S.-C.C.C. camp in determining the specific activities to be done on nonagricultural or forest land."

This group, the farmer membership of which constitutes a substantial majority, is one of the agricultural land use planning committees being set up in each agricultural county pursuant to the Mount Weather Agreement of July 8, 1938. These recommendations concerning the Forest Service are but a few among many dealing with the A.A.A., Farm Security Administration, Soil Conservation Service, and others. With these recommendations, the Ross County group is progressing rapidly toward a unified county program, which represents a major step in translating agricultural land use planning into action. And it is showing, too, the part that the U. S. Forest Service can play in county planning.

The county planning program, briefly stated, aims at combining farmer and technical opinion in guiding public programs, and encompasses the full range of problems that touch on the welfare of farms and farmers. Specifically, the goals of the program and the steps leading to them are shown in six important documents, each now available for study by the foresters and others who are affected by or interested in development of the land use program.

The Mount Weather agreement, the first of these documents, is a statement of objectives and general procedure for land use planning, as agreed upon by representative officials of the land grant colleges and leaders in the U. S. Department of Agriculture at a conference at Mount Weather, Va., July 1938. In that statement it was jointly declared that the "broad efforts" of the land grant colleges "to help farm people build comprehensive programs for rural improvement should be intensified," and that the colleges and the department should develop "a cooperative plan for building land use programs and policies and having such programs apply to varying local conditions."

The second of the documents is Work Outline No. 1, containing specific suggestions for a uniform approach in all states to the problem of developing a unified farmer-drawn program. Although most states are modifying this outline for use in the counties, its important features are being retained, in order that the results of local and state planning can be fitted into regional and national planning. This work outline calls for (1) mapping by state and local farmer committees, with the help of trained per-

[1]Barraclough, K. E. County land use planning. Jour. Forestry 37:460-461. 1939.

sonnel, of areas where farmers' problems are similar; (2) the classification of land according to the type of use for which it is best suited; and (3) definite plans and recommendations by the committees for improvement of present conditions.

The Secretary's order for reorganization of the U. S. Department of Agriculture, dated October 6, 1938, is the third document in this series. Under this order the Bureau of Agricultural Economics is selected as the agent for effecting a harmonious relationship among the agencies of the department that are dealing with various problems of land use. The Mount Weather agreement called for a close tie-up between these agencies, and the establishment of the Bureau of Agricultural Economics as the central planning unit for the department provides the machinery for such integration.

The fourth document is the *Memorandum of Understanding between the Bureau of Agricultural Economics and the Land Grant Colleges.* This serves as an over-all agreement between the two units, under which each year a number of cooperative projects will be conducted with the experiment stations and Extension Service. The fifth document is similarly a memorandum of understanding outlining the relationship of the Bureau of Agricultural Economics and other departmental bureaus and agencies in the light of the new department set-up. It gives a basis for translating planning into action, and for financing cooperative planning work in the states.

The sixth and final document in the series pertains to the unified county program, wherein the agencies of the government have cooperated in outlining a procedure to develop a unified county in at least one county, or area, in each state during the current year. The unified county program proposes to carry the work designed for intensive counties past the point of simple recommendations and to begin concrete action in these counties in 1940. It is intended to establish a fairly uniform procedure for coordination of departmental and state programs and related activities in effectuating the plans of these county planning committees. In some of the counties only slight changes may be needed in one or two of the programs; in others, many changes may be sought.

But no matter what the recommendations may be, the work in these unified program counties is a big part of a vigorous effort by the department to develop a "two-way channel" for the planning of agricultural programs, whereby farmer opinion can influence national farm programs, and technical counsel can be provided to farmers in arriving at planning decisions.

And therein lies the ultimate importance of county planning. Since our country has reached its maturity, planning has become necessary here as in the other countries of the world if agriculture is to be placed upon a more satisfactory economic, political, and social basis. That planning, however, must be democratic planning done not alone by a central government in Washington but in consultation with the farmers themselves. Foresters have a very important place in this kind of planning, which is, after all, purely a job of cooperation between all the people who have to deal with the problems of land use in relation to general agricultural problems. This is a task which will require the enthusiasm of all agencies working together toward a common goal.

WITH the recent signing of a forest fire protection agreement by the U. S. Department of Agriculture and the State of Colorado, the number of states cooperating with the federal government for the control of forest fire under the Clarke-McNary Act has been brought to 41 states and Hawaii, according to an announcement by the U. S. Forest Service. The seven states not participating in the federal-state program are Iowa, Kansas, Nebraska, North Dakota, Utah, Wyoming, and Arizona. The first four are in the Great Plains Region and have little forest land. Forest lands of the remaining three are mostly in national forests.

PRESENT DAY LAND UTILIZATION PROBLEMS[1]

By JOHN W. SPENCER

U. S. Forest Service

Public agencies administering public lands are confronted with many problems. Not the least important to these arise from the mismanagement of private lands within or adjacent to publicly owned areas. In order to remedy the present situation it will be necessary to revise the existing tax structure, regulate the use of private lands, expect more efficient land management, or acquire the lands by the public. Each of these remedial measures has some possibilities; in order to solve the problem all four must become effective.

THE U. S. Forest Service in contradistinction to the federal agencies which are working with agricultural lands is chiefly concerned with the management of wild lands, and wild lands which are already in public ownership.

Nevertheless fundamental governing principles should be the same in the management of wild lands as in all other land classes. Soil resources constitute the principal source of all wealth, past, present, and future. The proper management of wild lands under the dictum of preserving soil fertility and keeping the soil itself in place differs only in degree and in methods from that applicable to cultivated lands.

In the national forests land use involves the harvesting of the regular soil crops, timber and forage, and also the fullest possible realization of other public benefits inherent in the forests. For example, though water is not strictly a product of the soil, it is by far the most valuable resource emanating from the forests in the Central Rocky Mountain Region. Consequently, the dictates of good watershed management properly override all other considerations and govern the methods and degree of utilization in harvesting forest soil crops. Other valuable benefits such as scenery, out-door recreational use, and wildlife are derived from the forest wild lands, and are given specific consideration in management.

In short, national forest management follows the principle of multiple use. This means that each parcel of forest land is dedicated, as far as practicable, to that form of use which is of the greatest permanent public benefit.

Obviously the proper utilization of public lands under a regular system of permanent management is relatively simple and becomes essentially a question of sound administrative judgement.

The management of the public forests, however, is complicated by the presence within the forests of numerous parcels of privately owned land. These private holdings constitute only about 10 percent of the gross forest area in Region 2, but they create a problem of great local importance and wholly out of proportion to the actual acreage involved. These lands when they are abused or mismanaged, as is so often the case, may render ineffective or actually threaten the proper management of large contiguous areas of public property.

In short, at this point the Forest Service encounters exactly the same difficulty that confronts all public agencies dealing with land use. I shall discuss briefly this matter of privately owned problem lands, regardless of their location and without any especial reference to the national forests.

The time has long since passed when we can subscribe to the theory of rugged individualism whereby a landowner can do anything he wishes with his soil as long as he has fee simple title. We are gradually becoming aware that the landowner is in fact only a custodian and should be morally obligated to pass his land on with its basic soil capital unimpaired, for the benefit of future mankind. This theory may sound Utopian, but as a matter of fact it is only hard common sense based upon national self-preservation.

Our present land use difficulties cannot be blamed wholly upon short-sighted land proprietors. They arise out of a certain largeness or looseness of public thinking induced by a previous prodigality of soil resources. They spring from an economic system and form of self-government which compels a degree of exploitation

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[1]Presented at a meeting of the Central Rocky Mountain Section, Society of American Foresters, Denver, Colo., January 6, 1939.

beyond the sustained carrying capacity of too many soil classes.

Every acre of land is capable of producing a certain sustained yield in values of one kind or another. Some acres are so nearly worthless that they produce no tangible crops and realize their highest values if only they can merely be held in place, where they will not menace better soils and will require no expensive control work. Other soils are capable of producing periodic crops, but crops of such low gross value that the obligations of permanent private ownership cannot be met. In short, the poorer the land, and the less its sustained productive capacity, the more of a problem it represents.

In this day and age it is unthinkable that soil resources, no matter how poor or how limited in productive capacity, should be subjected to a system of exploitation that causes them to become even poorer. Deterioration of some land areas has already reached the point where the original productive capacity has been totally destroyed as far as man can tell, and the residual soil has become an actual menace.

In addition to these illustrations, we have the case of low grade lands which possess substantial or even very high public values wholly apart from the crops of the soil itself. An example is that of watershed lands, or of low grade range or brush lands on steep slopes where prevention of erosion and soil movement is of far more importance to the general public than anything else. The preservation of such public values is usually of no advantage whatever to the private owner and may only be an added burden. Obviously the preservation of such public values which do not redound directly to the benefit of the private owner should devolve upon the public.

There is no use in ranting about the existing ownership system or in heaping criticism upon either owners or local governments. We might better face the facts constructively. Our approach must be based upon the fundamental premise that the general public has a definite interest in the proper permanent utilization of all soil capital resources regardless of degree of soil value and regardless of ownership.

This premise is nothing more than an idle statement until we change our popular conception of land ownership responsibilities and drastically revise our present economic set-up to the point where proper land use becomes definitely profitable to the owner.

There are four general lines of remedial action: 1. Revision of the tax structure; 2. public regulation; 3. more efficient land management, and 4. public acquisition.

Revision of the tax structure.—Our present tax structure places a heavy burden upon land ownership. Only the better lands, and these most efficiently managed, are able to carry the load. The poorer lands, the so-called problem areas, are perforce subjected to rapid exploitation and abuse to a degree which cannot be maintained. As the poor lands become poorer and their tax contribution lessens, the burden increasingly shifts to the better lands. Thus the line of demarcation between profitable and unprofitable ownership gradually but steadily moves upward.

An obvious immediate remedy—the reduction of the cost of government through elimination of duplication, waste, and unnecessary activities—seems to have escaped public attention.

Replacement of real estate tax yields in part by income taxes, sale taxes, and the like may give a degree of relief. Consolidation of counties, elimination of duplicating local governments, consolidation of schools, and elimination of expensive public improvements in thinly settled areas, have great possibilities.

Nevertheless, without a long campaign of public education, there is little prospect of any substantial change. Conditions are certain to become worse before the public generally will awaken to the imperative need of revamping the tax structure. At the present time and probably for some years to come, we will be forced to consider our land use problem as it is related to the present tax system.

Public regulation.—The idea of forcing desirable land use practices upon the owner by legislation is dictated by larger public good. In so far as such desirable practices are actually profitable to the owner, who still has to meet his tax problems, the idea is sound. Beyond this point, regulation will not work. Whenever protection of public interests subjects the owner to extra expense, it narrows the profit margin and will inevitably force some lands into the unprofitable class. In all equity, the differential in cost between desirable and ordinary practices should be met by the public.

This is in effect a subsidy and is objectionable in that it produces no permanent cure and merely perpetuates the use and occupancy of border line, if not submarginal, lands.

Public regulation, therefore, is no general cure-all and can only be employed to a limited extent to cover certain phases of land use.

Efficient land management practices.—The work of certain agencies, notably that of the Soil Conservation Service, in instructing owners in desirable technical practices is extremely good and very much in the public interest. Recognition and universal adoption of these practices will be of tremendous importance in stopping soil losses and in restoring profitable operations upon lands that otherwise will degenerate into public problems. Nevertheless, even with the best efforts of the Soil Conservation experts there still remains a broad zone of lands which cannot carry the expense of any kind of sustained treatment.

Public acquisition.—Whenever any lands cannot pay their way permanently in private ownership regardless of any form of treatment, such lands become a definite public responsibility. The next logical step is to recapture the title so that restoration and future management will rest with the public and there will be no danger of such lands reverting again to private hands to go through the vicious cycle of exploitation and degeneration.

Low grade lands if converted into a public commons and managed by the public agencies on the basis of sustained crop production, however low that may be, will certainly never again become a public hazard. Furthermore, there is reason to believe that a partial return of receipts from such lands to the local tax treasuries will in the long run provide more actual revenue than the present hit or miss system of rotating private ownerships.

Recapture by the public of such lands should proceed on the basis of orderly purchase at fair market levels. No attempt should be made to coerce owners into sale.

All that is needed is to create a public fund and establish a sliding scale market by regions and soil classes. Private owners could thus always dispose of their problem lands at reasonable price levels just above any returns they could hope to receive through further exploitation followed by abandonment. The public in turn would be able to secure the lands before deterioration reached the point where expensive restoration measures are needed. The restoration of useless lands that threaten to become a menace is actually a public responsibility and one that will bulk larger as time goes on.

Whether we like it or not the United States is always going to have a public domain created out of those lands which cannot meet economic competition while in private hands.

The acquisition program is a large enough field to require the concerted effort of both state and federal governments and might just as well be faced by this generation in an orderly, systematic, and plan-wise manner.

No one of these measures will fill the bill, but if each of them is worked out wisely to fit those problems to which it particularly applies, then in the combination of all four, we will find our answer. Then and not until then can we hope to reach that goal where every acre of land in these United States is contributing in reasonable degree to the greatest permanent public good.

W. JEMTZEFF, writing in *Zeitschrift für Weltforstwirtschaft* for March 1939, describes a new Russian "combine" for harvesting timber. Like the combines used in harvesting wheat, this machine performs all the steps, including felling, limbing, cutting the stem into log lengths, sorting and bunching the logs, and piling the brush. Several experimental machines are in use. A new model, which won first prize in a recent competition, is 136 feet long, 14 feet wide, and 14 feet high. It weighs 35 tons, and requires sixty men to operate it. Data on performance are not presented.

A SLIDE RULE METHOD AS A SUBSTITUTE FOR STRAIGHT AXIS ALINEMENT CHARTS

By R. STAHELIN

Rocky Mountain Forest and Range Experiment Station

It is a common practice to present formulae containing several variables in the form of an alinement chart and solve the equation graphically. The graphic method saves time by obviating much computational work where a high degree of precision is not required. It is believed that the method proposed here will still further reduce the time required for solving equations containing from four to six variables, where the relationship between the variables is known and is expressed by a linear equation. The method, although probably not new, is presented here because many foresters may find it useful in their work since it is handier to operate than an alinement chart when more than three variables are involved.

THE procedure for operating and constructing the slide rule is illustrated with a four variable logarithmic equation as follows:

$$X_1 = 0.4410X_2 + 0.2745X_3 + 1.5666X_4 - 0.9181$$

This equation was obtained from an office report by E. M. Hornibrook on a growth and yield study of selectively cut stands of ponderosa pine in the Black Hills of South Dakota and Wyoming. The above equation gives future net yields in board feet per acre as a function of the volume of the reserve stand, the elapsed time in years since cutting and site index when:

X_1 = logarithm of future net yield in board feet.

X_2 = logarithm of volume of initial reserve stand in board feet.

X_3 = logarithm of number of years since cutting.

X_4 = logarithm of site index of the stand.

To obtain on the slide rule the net yield in 40 years of a selectively cut stand with an initial reserve volume of 4,000 board feet and a site index of 60 proceed as follows: set 40 years on the years-since-logging scale, $C(X_3)$, over 60 feet on the site index scale, $D(X_4)$, and read over 4 MBM on the reserve-stand scale, $B(X_2)$, read 7,870 board feet on the future-yield scale, $A(X^1)$, as shown in Figure 1.

The construction of the rule is very simple. The assignment of independent variables to the scales of the slide rule is entirely a matter of convenience. The dependent variable, yield in this example, must be put on one of the fixed scales on the slide rule. The graduations for the scale of the dependent variable (yield $= X_1$) can be copied directly from a sheet of semi-logarithmic paper. The graduations of the scales of the independent variables have to be modified by multiplying the spacing on the semi-logarithmic paper by the coefficient of the variable in the multiple linear equation. This is best done graphically on semi-logarithmic paper as shown in Figure 2. For the reserve stand scale X_2, for instance, the distance $0.441 \times AB$ is measured off on the axis AC. Setting a triangle on BC and moving it parallel to BC, the graduations between A and B are transposed to the line AC in the ratio of 1 to 0.4410. The distance AC must be laid off from A to D as many times as necessary till the logarithm of one is reached. Any number of whole cycles of the original logarithmic graduation AB may then be subtracted from the distance DA. Cutting off one cycle $DE = AB$, brings the starting point of the scale for X_2 to E in our example. The X_2 scale which is transferred to the slide rule is then $EA + AC$. The graduations however go only from A to C, unless it is desired to indicate lower values in the space EA, or higher values beyond C. The distance AC, which should normally lie to the left of A, was plotted to the right to save space.

The scales for the other independent variables are prepared in the same way. Care must be exercise that the starting points of the scales corresponding to the logarithm of one plus or minus any number of whole cycles of the original logarithmic scale be placed exactly under each other on the fixed and on the sliding part of the slide rule respectively. It is also important that the distance AB on the logarithmic paper be measured very exactly, since the transformed scale AC of that distance may have to be multiplied several times, which may cause even slight errors to become quite disturbing. It is very unfortunate that the length of one cycle on the 2-cycle semi-logarithmic paper printed by Keuffel and Esser (No. 358-63) is just a fraction less than 5 inches (about 4.9975 inches).

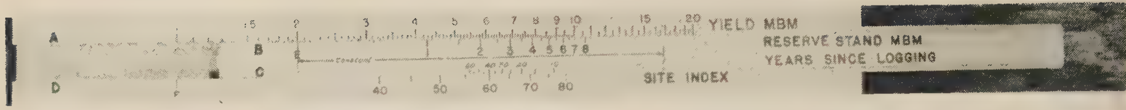

Fig. 1.—Slide rule setting for the net yield in 40 years of a stand growing on 60-foot land with a reserve volume of 4,000 board feet. The setting is as follows: set 40 years on the years-since-logging scale over 60 feet on the site-index scale; over 4,000 board feet on the reserve-stand scale read the net yield in 40 years, 7,870 board feet.

Table 1.—Computation by Logarithms of the Net Yield Determined by the Slide Rule Setting Shown in Figure 1

Variable	Scale	Value	Logarithm	Factor	Factor × logarithm	Cycles cut off	Slide rule value	Operation
Site index, X_4	D	60	1.77815	+1.5666	+2.78565	2	.78565	......
Years since logging, X_3[1]	C	40	1.60206	+ .2745	+ .43977	0	.43977	Add.
Constant	B	8.28	.91810	......	— .91810	0	.91810	Subtr.
Reserve stand, X_2	B	4000	3.60206	+ .4410	+1.58851	1	.58851	Add.
X_1	A	7867	......	......	3.89583	3	.89583	

[1]The actual setting is —(0-0.43977) = +0.43977.

The constant factor in the equation may be added to any scale, wherever it is most convenient. The C scale, written on the lower part of the tongue of the slide rule should be graduated in reverse order to save one move.

The theory underlying this method will become clearer, when the process of the slide rule setting given in Figure 1 is followed through mathematically as shown in Table 1.

Formula: $X_1 = 0.4410X_2 + 0.2745X_3 + 1.5666X_4 — 0.9181$.

Example: log. 7867 = 0.4410 log. 4000 + 0.2745 log. 40 + 1.5666 log. 60 — 0.9181.

The same procedure can be applied to an arithmetic equation by using ordinary cross section paper as a basis for the graduations of the scales instead of logarithmic paper.

To solve an equation with five variables, two scales may be put on the C scale of the slide rule. The graduations for the X_4 variable are written to the left and those for the X_3 variable to the right from a common point corresponding to the logarithm of one (zero point on arithmetic paper) plus or minus any number of whole cycles. The reading of X_4 on scale C left is set over the reading of X_5 on scale D. The cross hair of the slide rule runner is then set on the reading of X_3 on scale C to the right. The origin of the B scale corresponding to the logarithm of 1 plus or minus any number of whole cycles is set on the cross hair and the value of X_1 on the A scale read over the reading of X_2 on the B scale. This operation necessitates two settings of the slide rule compared to three moves with the alinement chart, or a saving of one move as in the case of the equation with four variables. By putting two scales in a similar way also on the B scale, an equation with six variables can be solved with two settings, saving two moves compared with the alinement chart method. In the case of three variables the choice between the slide rule and the alinement chart is a matter of personal pref-

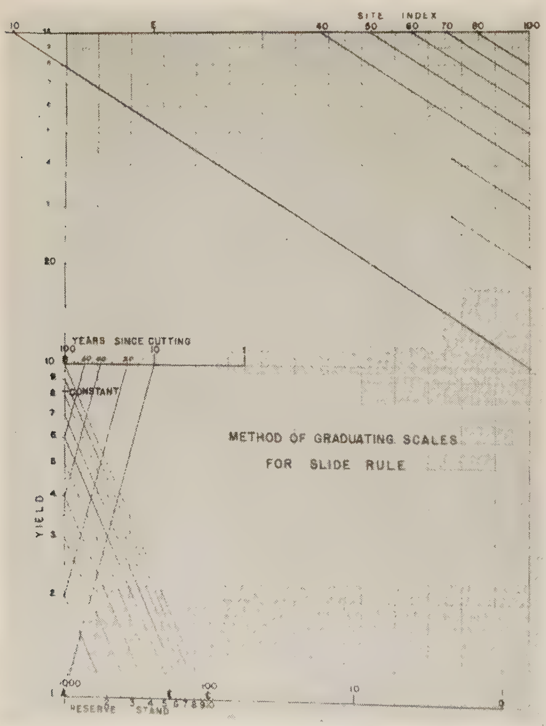

Fig. 2.—Shows a graphic method for graduating the slide rule scales.

erence. For more than six variables both methods become rather complicated.

The chief disadvantage of the described method is that it is limited to straight line relationships between the variables for which the equation is known. The relative importance of the different variables in contributing to the final answer is, however, revealed more clearly by the slide rule method, than by the alinement chart. The crowded appearance of certain scales on the slide rule may at first seem disturbing. However, after the seemingly large scales on the alinement chart have been projected on the line on which one has to hold the point and on to the axis, where the final reading is made, the useful spacing becomes identical in both methods.

THE APPLICATION OF A TREE CLASSIFICATION IN MARKING LODGEPOLE PINE FOR SELECTION CUTTING

By R. F. TAYLOR

Rocky Mountain Forest and Range Experiment Station

In 1937 there appeared in the JOURNAL OF FORESTRY a scheme for classifying lodgepole pine trees into four vigor classes on the basis of external appearances. Since that time rigid tests of application have been made with the result that additional and revised data which supersede the original presentation are available. By use of this tree classification system guess work is largely removed in selecting a reserve stand with the greatest possible growth potentialities.

A CLASSIFICATION scheme for lodgepole pine trees in Colorado and Wyoming which recognized four vigor classes based on external appearances was described in 1937 (*6*). Since that time this classification scheme has been applied and checked in actual practice, and sufficient new data are available to effect a complete revision of the original presentation. The following discussion outlines the needed modification of the original classification, presents additional data on growth and general characteristics of the tree classes, and indicates further application of the scheme in selection of trees for the reserve stand.

THE REVISED CLASSIFICATION

Representative trees of the four vigor classes of the revised classification are presented diagrammatically in Figure 1. The present class A combines the original classes A and B, while the revised classes B and C are divisions of the original class C which as first defined contained too wide a range of volume to be practical. Class D remains without change.

DESCRIPTION OF VIGOR CLASSES[1]

Class A—Crown area:[2] 30 percent or more of the "extreme maximum" outline of vigor class A. Crown length: 50 percent or more of the bole length. Crown vigor: dense, full, of good color, and pointed.

Class B—Crown area: usually more than 30 percent but less than 50 percent of the "extreme maximum" outline of vigor class A. Crown length: usually more than 50 percent but less than 60 percent of the bole length. Crown vigor: moderately dense, of good color, pointed or slightly rounded.

Class C—Crown area: 17 to 30 precent of the "extreme maximum" outline of vigor class A. Crown length: 40 to 50 percent of the bole length except for trees with distinctly better than average vigor when a minimum of 20 percent of the bole length is sufficient. Crown vigor: sparse, bunchy, color poor, never pointed.

Class D—All live trees of poorer vigor than Class C. Includes trees with class A, B, or C outlines but with dying tops or stagheads.

STRUCTURE OF UNCUT STANDS BASED ON REVISED CLASSIFICATION

The approximate average stand structure based on the revised classification is presented in Table 1. Classes A and B are combined in considering

[1]Frequently combinations of these characteristics occur that are difficult to interpret. For example, certain trees may have class A outlines but have an extremely sparse crown. Also trees may have a sharply pointed top and a short but wide crown. In spite of these exceptions, however, these trees on the basis of growth capacity are ordinarily in class A or B. With practice these and other exceptions will become familiar.

[2]Crown area as described for each class refers to area in longitudinal section.

structure because they require the same silvicultural treatment and consideration in the stand even though they do not respond equally well to release.

TABLE 1.—VOLUME PER ACRE BY TREE CLASS GROUPS
(Trees 10 inches d.b.h. and larger)

Tree class	A and B	C	D	Total
	Volume in feet b.m.			
Poor stands	941	4,952	1,974	7,867
Medium stands	4,314	3,962	1,616	9,861
Good stands	5,574	10,303	448	16,325
Exceptional stands	9,291	4,576	3,457	17,324

GROWTH OF TREE CLASSES BEFORE AND AFTER RELEASE

Dunning (*2*), in studying ponderosa pine tree classes after release, observed that a decrease in vigor occurred more commonly than an increase. Realizing that perhaps this might be characteristic of lodgepole pine also, a series of increment borings were made in a stand cut selectively in 1928. The trees were classified by vigor classes at the time the borings were made. The growth of an average of two cores per tree was measured with a binocular microscope and core measuring device. It was assumed that if changes from one vigor class to another after release are of significance in dealing with the average performance of the stand, they would show up by plotting and comparing diameter growth before and after cutting.

From the results presented in Figure 2, it appears that vigor classes on the average do not change within at least eight years after cutting, and evidence is presented in Figure 4 to indicate that for the stand as a whole no significant changes take place over a period of 30 years after cutting.

AMOUNT OF RELEASE

No thorough study of release after cutting of lodgepole pine has been made, but preliminary

Fig. 1.—Diagram of tree vigor classes.

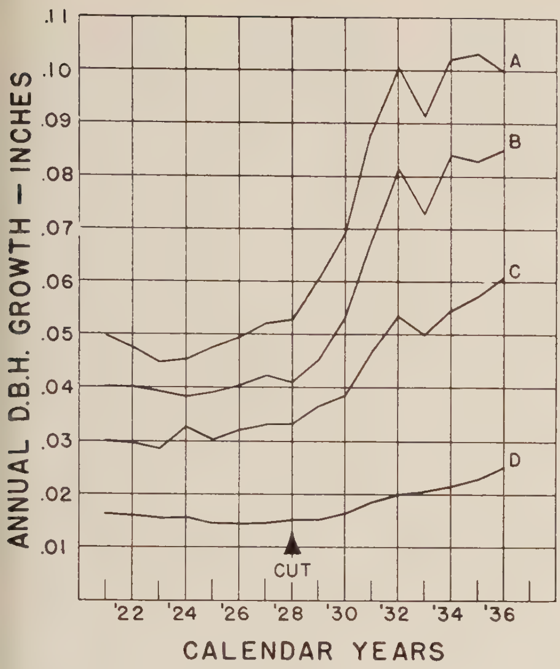

Fig. 2.—Growth of tree vigor classes before and after selection cutting. Basis 193 trees.

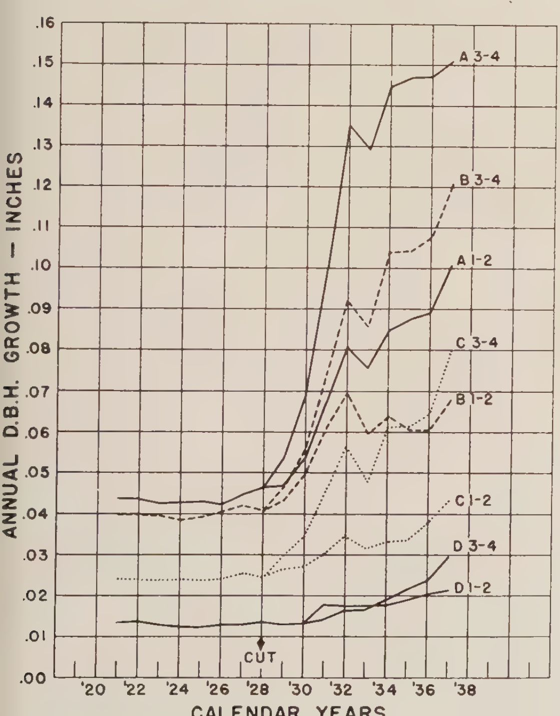

Fig. 3.—Growth of tree vigor classes by amount of release, combining release in 1 to 2 quadrants and in 3 to 4 quadrants. Basis 110 trees.

data indicate that one tree of competing size, removed in each of four quadrants of a circle 40 feet in diameter, surrounding the reserved tree, gives the most effective release. More than one such tree removed per quadrant appears to have no additional release effect. An earlier discussion of lodgepole pine tree classes (*6*) has shown that there is a marked difference in growth of individual tree classes with different amounts of release. At this time, however, additional data are available and it is possible to present growth after release in a more practical way.

Data on growth by tree classes and degree of release are presented in Figure 3. It is obvious

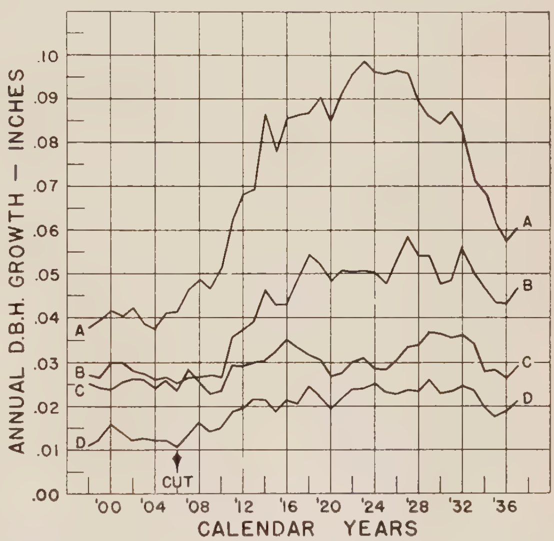

Fig. 4.—Duration of released growth on two areas cut the same year. Data combined. Basis 48 trees.

from these data that growth is accelerated greatly in direct relation to the vigor of the tree and the amount of release. Minor inconsistencies in the exact trend are attributable undoubtedly to sampling error. The necessity for releasing reserved trees to obtain maximum growth is obvious. Furthermore, it is apparent that class D trees do not respond adequately even when given maximum release.

Duration of Accelerated Growth Following Release

Two stands cut over 31 years ago were sampled to determine whether growth acceleration due to release was decreasing materially. The combined growth curves for the two areas are presented in Figure 4. It is apparent that a marked lowering of growth rate occurs at from 14 to 18 years after

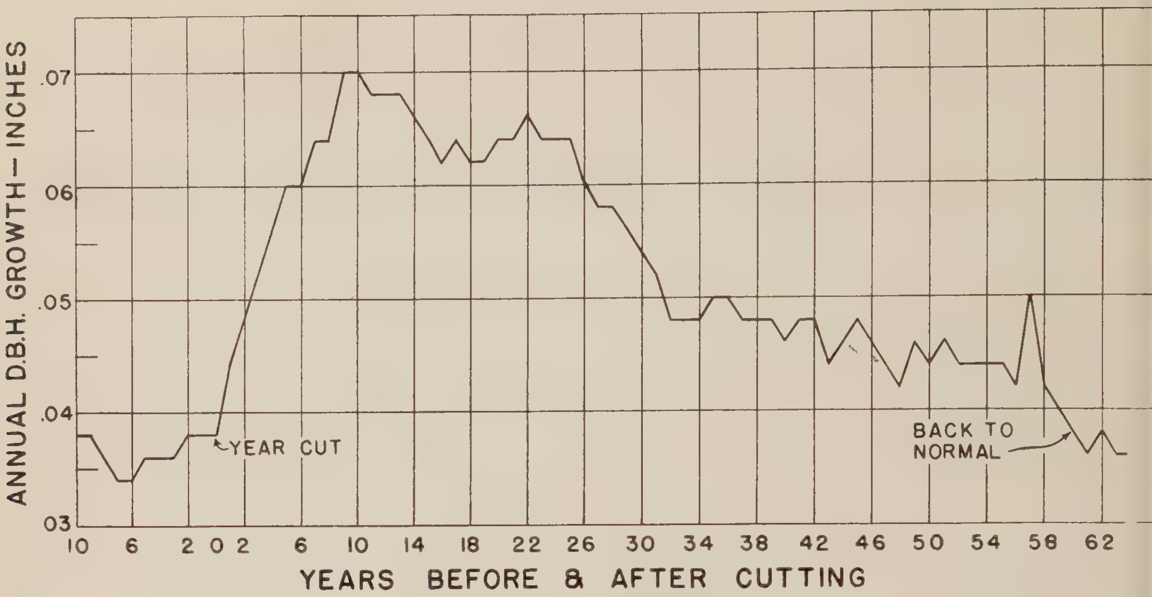

Fig. 5.—Duration of released growth of 138 class B trees from 20 yield plots partially cut 30 or more years ago.

release and that a large part of the increased growth has faded in 30 years. Both duration and amount of increased growth probably vary to some extent with amount of release and site conditions. As further evidence a composite curve of growth for 138 class B trees in stands released 30 years or more is presented in Figure 5. Here again, a significant decline in growth rate begins at about 14 years and carries forward until practically all evidence of accelerated growth disappears about 60 years after cutting. For ponderosa pine Dunning (*1*, *2*) expected maximum acceleration to be reached in 9 years and to culminate within 15 years. Meyer (*4*) and Pearson and Folweiler (*5*) expect accelerated growth to last 40 years in ponderosa pine under average climatic conditions.

Growth in Diameter Classes

Lodgepole pine trees larger than 17 inches d.b.h. seldom occur in Colorado and Wyoming. A typical stand on 100 acres of sample plots in central Colorado averaged only two trees 17 inches d.b.h. and larger in a total of 118 trees 9.6 inches d.b.h. and larger per acre. Where large lodgepole pine does occur it has been the practice to designate trees more than 17 inches d.b.h. for cutting, the assumption being that lodgepole pine rarely grows larger than 17 or 18 inches in diameter and, consequently, that re-

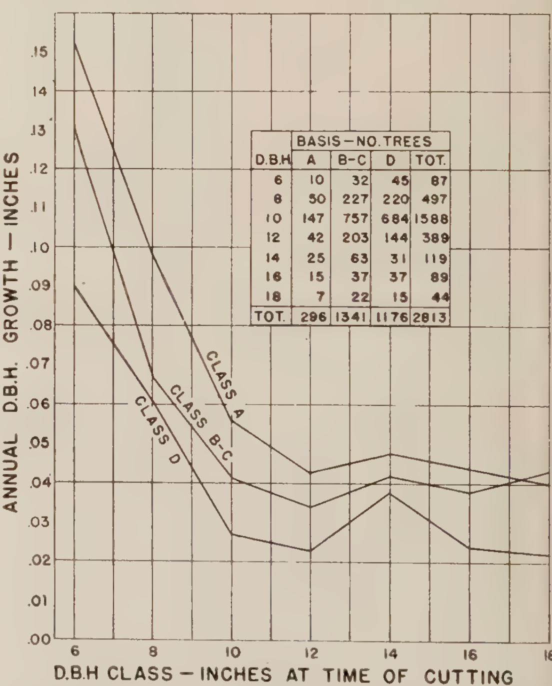

Fig. 6.—Diameter growth after release of reserved trees, by diameter classes. Average period of release 34 years.

lease would have little effect. To check this hypothesis, data based on 2,813 trees measured on temporary sample yield plots scattered throughout Colorado and Wyoming have been plotted in

Figure 6. The trees on these plots were classified in 1937 according to the original scheme and the curves are expressed according to the revised scheme, consequently it is necessary to express class B and C curves as a composite one. The average period since the plots were cutover is 34 years and each tree averaged release on two sides.

Figure 6 is self-explanatory and disproves the assumption that trees 17 and 18 inches d.b.h. are not responsive to release. Apparently, response to release is correlated with diameter until the 12-inch d.b.h. class is reached, after which there is no significant difference. As cutting is confined ordinarily to trees 10 inches d.b.h. and larger there appears to be little choice if selection is based on accelerated growth. A tree 10 inches d.b.h. may grow a little faster than a larger tree in the same vigor class, but the larger one increases more in volume with the same diameter increase. Krauch (*3*) obtained somewhat similar results for ponderosa pine, but in the stands in which he worked age was correlated with diameter, whereas a similar correlation is not apparent in lodgepole pine stands.

Application of the Classification to Selection Cutting

It should be stressed that the tree classification is based upon averages for the class and that conclusions such as the following are to be considered as applying to the stand as a whole and not to the individual tree:

(1) With the same degree of release, the fastest rate of growth in the reserve stand will be made by the class A trees, followed in order by class B, C, and D trees.

(2) No amount of release will result in a class D tree increasing its growth enough to compare with a class C tree released only moderately. A class C tree released in three or four quadrants may grow as fast or perhaps faster than a class B tree released in only one or two quadrants. Class A trees with release in three or four quadrants will grow faster than any other classes regardless of release. A reserve stand composed of class A and B trees will grow faster than one composed of C and D trees. A stand composed of class A, B, and a few class C trees, with all trees released as much as possible, is the best type of reserve stand ordinarily obtained under actual conditions.

(3) The increased growth due to release begins to decrease in 14 to 18 years and by 30 years has made a very marked decline.

(4) Trees 18 inches d.b.h. will probably respond to release as much as trees 12 inches d.b.h. although trees smaller than 12 inches d.b.h. show a greater response.

(5) The merchantable lodgepole pine stands in Colorado and Wyoming are at best even-aged only in small groups. Under no condition has a correlation between age and diameter been observed.

Preliminary lodgepole pine yield data for selectively cut stands based on 85 one-acre sample plots scattered throughout the range of lodgepole pine in Colorado and Wyoming indicate that the greatest yields are obtained with reserve stands of about 5,000 feet b.m., and a 30-year cutting cycle. Data on mortality of lodgepole pine are meager but on the basis of the best judgment available a reserve stand of less than 3,500 feet b.m. is considered risky from the standpoint of windfall. It is recommended more or less empirically, therefore, that the reserve stand contain a minimum of 3,500 feet b.m. per acre and a maximum not much greater than 5,000 feet b.m. per acre. A reserve stand having as close to 5,000 feet b.m. per acre as possible, and composed of the best tree classes obtainable in that stand should be a general objective. Regardless of conditions, reserve stands containing more than 50 percent by volume of class C trees should be avoided as the low rate of net growth in such a stand would probably compare unfavorably in the long run with the growth of a new stand obtained by clear-cutting.

The method of application of the tree classification to marking lodgepole pine in Colorado and Wyoming may be summarized as follows:

1. Determine by sample strips the approximate total merchantable volume per acre and the proportion of this volume in the classes A and B and in classes C and D.

2. When cutting selectively leave as nearly as possible 5,000 board feet per acre but never less than 3,500 board feet. No trees should be cut in the classes A and B (except in case of insects, rot, or other defect) unless the stand contains more than 5,000 board feet per acre in these groups.

3. Cut all class D trees, and all class C trees not needed in the reserve stand. Class C trees, if left, should be released in more than two quadrants. Release all reserved trees as much as possible.

4. Cut all trees 17 inches d.b.h. and larger regardless of the fact that trees of this size are capable of release. Further study will be made to determine the reasons why lodgepole pine seldom attains diameters greater than 17 inches in Colorado and Wyoming.

The application of the tree classification principle is demonstrated in Table 2 where hypothetical volumes by classes are given to illustrate satisfactory structure of the reserve stand. Obviously classes A and B are the key, inasmuch as they should be left intact (unless in excess of 5,000 feet b.m. per acre) and the volume left in class C should not exceed the combined volume in the first two classes (volume in class C trees should never exceed 50 percent of the total reserved stand). Note that as volume in classes A and B increases, the volume in class C increases proportionately until 2,500 board feet is reached, after which an increase in classes A and B results in a decrease in class C. When a volume of 5,000 board feet in classes A and B is reached no class C trees are needed in the reserve stand.

TABLE 2.—RESERVE STANDS ACCORDING TO VOLUME IN TREE CLASSES

Volume per acre in classes A and B	Volume reserved in class C	Total reserved stand
Volume in feet, board measure		
1,750	1,750	3,500
1,800	1,800	3,600
2,000	2,000	4,000
2,500	2,500	5,000
3,000	2,000	5,000
4,000	1,000	5,000
5,000	--------	5,000
6,000	--------	6,000

Field study has shown that the method of cutting following the tree classification scheme in Colorado and Wyoming will result, on the average, in removing approximately 65 percent of the merchantable volume in the first cut. No stand has been studied where the cut would be less than 55 percent of the total merchantable volume and if such a stand is encountered local conditions will dictate the method of cutting rather than the system suggested herein. In stands so decadent that less than 1,750 feet b.m. per acre occurs in classes A and B, marking can be dispensed with and all merchantable trees larger than 10 inches d.b.h. removed. If selection cutting is attempted in decadent stands the reserve will either be composed of trees incapable of accelerated growth or the stand will be so open that extremely high mortality will result from windfall.

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THE USE OF UNIT COST DATA IN ESTIMATING LOGGING COSTS AND PLANNING LOGGING OPERATIONS

By D. M. MATTHEWS
University of Michigan

The necessity for adapting logging methods to the requirements of selective cutting and to the test of low-cost production has raised many practical questions, such as which is cheaper, teams or tractors? What is the proper spacing for skid roads? Can such problems be determined short of actual trial? This article illustrates for southern conditions how such questions can be answered if a small amount of basic data about the stand and suitable production costs is available.

FROM data collected on a southern operation by R. R. Reynolds, Crossett Experimental Forest, Crossett, Ark., it has been possible to prepare Tables 1 and 2 showing the cost of hauling southern pine logs on trucks and the cost of bunching logs with teams. These data are not to be considered standard for any region or job. Similar data, however, can be inexpensively collected for any operation. The purpose of this paper is to demonstrate how such data can be used.

Let us assume that the following data are available for a stand of timber which is to be logged:

Average stand per acre, Doyle-Scribner scale, 5,000 bd. ft.	
Average d.b.h. of stand	16 inches
Hauling distance on dirt road	2½ miles
Maximum hauling distance in woods	8,000 feet
Average hauling distance in woods	4,000 feet
Hauling conditions in woods	fair
No swamping for trucks necessary.	

From Tables 1 and 2 we can estimate the probable cost of logs on trucks at the delivery point to be as follows:

	Per M	Per M
Fixed cost of bunching	$ 0.45	
Variable cost for 100 feet distance	0.18	
Total		$ 0.63
Loading truck-team at 1.125 cents per minutes—30.6 minutes		0.34
Fixed time cost of truck while loading	0.22	
Hauling in woods an average distance of 4,000 feet at 1.43 cents per 100 feet	0.57	
Hauling on road 13,200 feet at 0.36 cents per 100 feet	0.47	
Total hauling cost		1.26
Total cost at delivery point		$2.23

Let us now assume that a selective plan of logging has been proposed under which only 2.5 M feet b.m. will be cut per acre and that this practice will raise the average d.b.h. of the timber taken to 20 inches. What will be the probable cost per M feet b.m. under this plan?

	Per M	Per M
Fixed cost of bunching	$ 0.28	
Variable cost of bunching 150 feet	0.27	
Total		$ 0.55
Loading truck—30.6 minutes at 1.125 cents		0.34
Fixed time cost of truck while loading	0.17	
Hauling in woods—4,000 feet at 1.1 cents per M per 100 feet	0.44	
Hauling 13,200 feet on road at 0.28 cents per M per 100 feet	0.37	
Total hauling cost		0.98
Total cost at delivery point		$1.87

The foregoing total costs may seem satisfactory (they may even appear extraordinarily low to northern operators), but it is to be noted that the cost of hauling per 100 feet of distance per M feet b.m. on the road is only 25 percent of the cost of hauling in the woods. It can be demonstrated that when the hauling cost on roads is less, per unit distance, than one-half the cost of hauling in the woods it will pay to put in roads on some spacing provided the width of the belt of timber to be logged is not less than the spacing of the roads. What this spacing should be is the important point.

The economic spacing of roads will vary with three factors: 1. The cost of construction of the roads, 2. The volume per acre to be removed, and 3. The cost of hauling per M per 100 feet of distance in the woods.

The cost of road construction per M can be expressed as $R/12.1/VS$ where R is the cost of construction of roads per mile, 12.1 is the acreage served by a mile of road on a spacing of 100 feet, V is the volume per acre, and S is the spacing of roads in units of 100 feet.

The cost of hauling in the woods can be expressed as $C\ S/4$ where C is the cost of hauling per M per 100 feet of distance in the woods and S is the spacing of roads in units of 100 feet. This is because when we build roads our maxi-

mum haul in the woods will be $S/2$ or one-half the distance between the roads, and our average haul will be one-half this distance or $S/4$. Minimum cost will be obtained when these two costs are equal or when

$$C\frac{S}{4} = \frac{\frac{R}{12.1}}{VS} \text{ and solving for } S \text{ we get } S = \sqrt{\frac{\frac{4R}{12.1}}{VC}} \text{ or } \sqrt{\frac{.33R}{VC}}$$

Roads of the character used in the South can be constructed at a cost of about $100 per mile where fair hauling conditions exist in the woods. With this cost estimated we can turn to our cost tables and find that $C = 1.43$ cents per M per 100 feet of distance.

If 5M feet b.m. are to be removed per acre the values for insertion in the formula are:

$R = 10{,}000$ cents
$C = 1.43$ cents
$V = 5$ M whereupon

$$S = \sqrt{\frac{.33 \times 10{,}000}{5 \times 1.43}} \text{ or } \sqrt{\frac{3300}{7.15}} =$$

$\sqrt{461}$ or 21.5 hundred feet.

Therefore, since the timber belt is wider than 2,150 feet, roads should be used and spaced about 2,150 feet apart—from 2,000 feet to 2,300 where possible.

Let us now demonstrate the advisability of road construction by calculating cost with and without roads:

	Cost per M feet b.m. Without roads	With roads
Cost of bunching (unchanged)	$0.63	$0.63
Cost of loading truck (unchanged)	0.34	0.34
Fixed cost of truck while loading (unchanged)	0.22	0.22
Hauling in woods an average distance of 4,000 feet @ 1.43 cents per 100 feet	0.57	
Hauling in woods an average distance of $\frac{2150}{4}$ feet @ 1.43 cents per 100 feet		0.077
Hauling on roads—13,200 feet @ 0.36 cents per 100 feet	0.47	
Hauling on roads when woods roads are used—distance increases to 13,200 + 4,000 feet or 17,200 feet @ 0.36 cents per 100 feet		0.51
Cost of roads: With a road spacing of 2150 feet the acreage served by one mile of road is 260 acres. Cost per acre $= \frac{\$100}{260} = 38.4$ cents. Cost per M $= \frac{38.4 \text{ cents}}{5}$		0.077
Total cost	$2.23	$1.96

Saving per M feet b.m. by use of roads: 27 cents.

The foregoing estimates are for fairly easy logging conditions, and where these obtain there is no cheaper method of getting out logs than by

Table 1.—Cost of Hauling Logs with 1½-ton Truck and Trailer[1]

Av. d.b.h. of stand	Load: Number trees	Load: Doyle-Scribner scale	Set, load, and bind	Fixed time cost	Fixed time cost per M	Hauling cost per 100 feet of distance (Costs as above divided by average load in feet b.m.): Dirt road	Woods hauling conditions: Good	Fair	Poor
Inches		*Bd. ft.*	*Minutes*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*
12	13	715	37.8	27.4	38.0	0.50	1.16	2.00	4.00
16	7	1,000	30.6	22.2	22.0	0.36	0.88	1.43	2.86
20[2]	5	1,300	30.6	22.2	17.0	0.28	0.64	1.1	2.20

[1]Based on the fixed cost per minute while loading, 0.725 cents; operating cost per 100 feet of hauling distance via dirt road, 0.36 cents; woods hauling conditions good, 0.884 cents; fair, 1.43 cents; poor, 2.86 cents.

[2]It is assumed that the cost of hauling in stands where the average diameter of the timber is greater than 20 inches would not decrease materially because the load could not be greatly increased and the fixed time would remain about the same.

Table 2.—Cost of Hauling or Bunching Logs with Teams based on an average cost of 1.125 cents per minute for team and driver

Av. d.b.h. of stand	Load: Number trees	Load: Doyle scale	Hook and unhook time	Delay time	Total fixed time	Fixed time cost	Fixed time cost per M ft. b.m.	Time per 100 feet of distance	Cost per 100 feet of distance	Cost per M feet b.m. per 100 feet of distance
Inches		*Bd. ft.*	*Minutes*	*Minutes*	*Minutes*	*Cents*	*Cents*	*Minutes*	*Cents*	*Cents*
12	1	60	2	3	5	5.6	93	2.00	2.25	37
16	1	150	2	4	6	6.8	45	2.50	2.8	18
20	1	280	2	5	7	7.9	28	4.40	5.0	18
24	1	430	2	6	8	9.0	21	6.80	7.7	18

the use of trucks for hauling in the woods and teams to bunch the logs. Such conditions are rare, however, for year-round logging, and as surface conditions in the woods become poor for trucks it is usually found that considerable expenditure has to be incurred in swamping out truck routes. Costs may then rise so rapidly that it will pay to keep trucks on roads at all times. Moreover, if year-round logging is contemplated, all-weather roads with a gravel surface may be required which will cost as much as $750 per mile.

When roads costing this amount per mile to build are to be used the spacing on which they are located becomes very important; first, because their cost may be very high per M feet b.m. if they are spaced too closely, and second, because the cost of skidding with horses and/or tractors may be out of line with other costs if they are spaced too far apart.

Through courtesy of the Caterpillar Tractor Company data have been supplied on which Table 3 for tractor skidding costs is based. The costs apply to the skidding of tree-length southern pine logs by tractors equipped with towing winches. The company emphasizes the fact that these data cannot be considered standard for the region, but merely indicate probable cost under average conditions. Data of this character should be collected for specific situations before being used as a basis for planning operations or estimating costs.

These data in Table 3 are comparable to the costs presented in Table 2 for skidding with teams, and it is to be noted that whereas, for small sized timber, the team costs show a lower fixed component than the tractor costs, the latter are uniformly lower for the variable cost component expressed as cost per M feet b.m. per 100 feet of distance. From this it is evident that, when roads can be cheaply constructed and therefore closely spaced, team skidding may be more economical than the use of tractors. However, when roads are expensive and the stand per acre light, roads should be spaced further apart, and then as the skidding distance is thus increased the tractor becomes the more economic skidding device.

This fact is easily demonstrated by plotting the costs of skidding 16-inch timber by team and by an RD4 tractor, for various skidding distances, in the form of a break-even diagram (Fig. 1).

Figure 1 shows that the lines of total cost cross at a skidding distance of about 300 feet. This means that where it is necessary or economical to have roads spaced 1,200 feet or less apart, so that the average skidding distance is 300 feet or less, team skidding will probably show the lowest cost per M feet b.m. When topography or economy dictates a wider spacing than 1,200 feet for roads, tractors will be the more economical skidding device, and the total saving resulting from their use will increase rapidly as it is possible economically to increase the spacing of the roads.

As a final illustration of the use of the cost tables and the spacing formula in selecting equipment and planning the logging operation, let us deal with two other assumed sets of conditions for the area which we have previously considered suitable for truck logging without skidding.

First case.—Ground conditions are such that trucks cannot be used in the woods, but roads can be constructed which will cost only $200 per mile to build. The operator has to decide whether to use teams or RD4 tractors, and how far apart he should locate his roads (a) for a cut taking 5M feet b.m. per acre with timber averaging 16 inches d.b.h. and (b) for a cut taking 2.5 M feet b.m. per acre with timber averaging 20 inches d.b.h.

When 5 M feet b.m. are to be logged per acre the costs involved for teams are:

Fixed skidding cost .... 45 cents per M
Variable skidding cost .... 18 cents per M per 100 feet
Road cost .... $200 per mile

$$\text{Spacing } S = \sqrt{\frac{.33 \times 20{,}000}{5 \times 18}} \text{ or } 8.6 \text{ hundred feet}$$

The costs involved for tractors are:

Fixed skidding cost .... 70 cents per M
Variable skidding cost .... 9.7 cents per M per 100 feet
Road cost .... $200 per mile

$$\text{Spacing } S = \sqrt{\frac{.33 \times 20{,}000}{5 \times 9.7}} \text{ or } 11.7 \text{ hundred feet}$$

Costs can now be estimated as follows:

	Cost per M feet b.m. Tractor	Team
Fixed skidding cost		$0.45
Variable skidding cost $\frac{8.6}{4} \times 18$ cents		0.38
Road construction costs		0.38
Fixed skidding cost	$0.70	
Variable skidding cost $\frac{11.7}{4} \times 9.7$ cents	0.28	
Road construction cost	0.28	
Total	$1.26	$1.21

The use of the team method of skidding is justified.

When 2.5 M feet b.m. only are to be logged per acre the costs involved for teams are:

Fixed skidding cost .... 28 cents per M
Variable skidding cost .... 18 cents per M per 100 feet
Road cost .... $200 per mile

$$\text{Spacing } S = \sqrt{\frac{.33 \times 20{,}000}{2.5 \times 18}} \text{ or } \ldots \text{ 12.1 hundred feet}$$

The costs involved for tractors are:

Fixed skidding cost .... 43 cents per M
Variable skidding cost .... 6.8 cents per M per 100 feet
Road cost .... $200 per mile

$$\text{Spacing } S = \sqrt{\frac{.33 \times 20{,}000}{2.5 \times 6.8}} \text{ or } \ldots \text{ 19.7 hundred feet}$$

Costs can be estimated as follows:

	Cost per M feet b.m. Tractor	Team
Fixed skidding cost		$0.28
Variable skidding cost $\frac{12.1}{4} \times 18$ cents		0.55
Road construction cost		0.55
Fixed skidding cost	$0.43	
Variable skidding cost $\frac{19.7}{4} \times 6.8$ cents	0.33	
Road construction cost	0.33	
Total	$1.09	$1.38

The lighter cut per acre compels a wider road spacing which in turn calls for the use of the tractor.

Second case.—Ground is soft, and cheap roads are impassable during rainy periods which are of

Table 3.—Cost of Skidding Logs with Various Types of Caterpillar Tractors

Av. d.b.h. of stand	Load Doyle-Scribner scale	Hook and unhook time	Delay time	Total fixed time per turn	Cost at above charge per minute	Fixed time cost per M ft. b.m.	Hauling cost per M ft. b.m. per 100 ft. of hauling distance
Inches	*Bd. ft.*	*Minutes*	*Minutes*	*Minutes*	*Dollars*	*Dollars*	*Dollars*
			D2 (at $ .0230 per min.)				
12	110	5	2	7	$ .161	1.46	.230
16	230	4	2	6	.138	.59	.107
20	325	3	2	5	.115	.34	.078
24	395	2	2	4	.092	.23	.064
28	455	2	2	4	.092	.20	.055
			D4 (at $ .0286 per min.)				
12	150	7	2	9	.257	1.71	.210
16	325	6	2	8	.229	.70	.097
20	470	5	2	7	.200	.43	.067
24	380	4	2	6	.172	.29	.054
28	640	3	2	5	.143	.22	.049
32	680	2	2	4	.114	.17	.046
			D6 (at $ .0360 per min.)				
12	210	10	2	12	.432	2.06	.190
16	445	8	2	10	.360	.81	.089
20	620	6	2	8	.288	.46	.064
24	780	5	2	7	.252	.32	.050
28	885	4	2	6	.216	.24	.044
32	975	3	2	5	.180	.18	.041
			D7 (at $ .0461 per min.)				
16	610	10	2	12	.553	.91	.083
20	870	8	2	10	.461	.53	.058
24	1,090	6.5	2	8.5	.392	.36	.046
28	1,225	5	2	7	.323	.26	.041
32	1,360	4	2	6	.277	.20	.037
36	1,410	3	2	5	.230	.16	.036
40	1,475	3	2	5	.230	.16	.034

frequent occurrence. Graveled roads will have to be used which will cost $750 per mile to build. How far apart should such roads be spaced for a cut of 5M feet b.m. per acre and for a cut of 2.5 M feet b.m. per acre, and should teams or tractors be used?

When 5 M per acre are to be removed with team logging the costs involved are as follows:

Fixed skidding cost	45 cents per M
Variable skidding cost	18 cents per M per 100 feet
Road construction cost	$750 per mile

Spacing $S = \sqrt{\dfrac{.33 \times 75{,}000}{5 \times 18}}$ or 16.6 hundred feet

When tractors are to be used costs involved are:

Fixed skidding cost	70 cents per M
Variable skidding cost	9.7 cents per M per 100 feet
Road construction cost	$750 per mile

Spacing $S = \sqrt{\dfrac{.33 \times 75{,}000}{5 \times 9.7}}$ or 22.6 hundred feet

Costs can be estimated as follows:

	Cost per M feet b.m. Tractor	Team
Fixed skidding cost		$0.45
Variable skidding cost $\dfrac{16.6}{4} \times 18$ cents		0.75
Road construction cost		0.75
Fixed skidding cost	$0.70	
Variable skidding cost $\dfrac{22.6}{4} \times 9.7$ cents	0.55	
Road construction cost	0.55	
Total	$1.80	$1.95

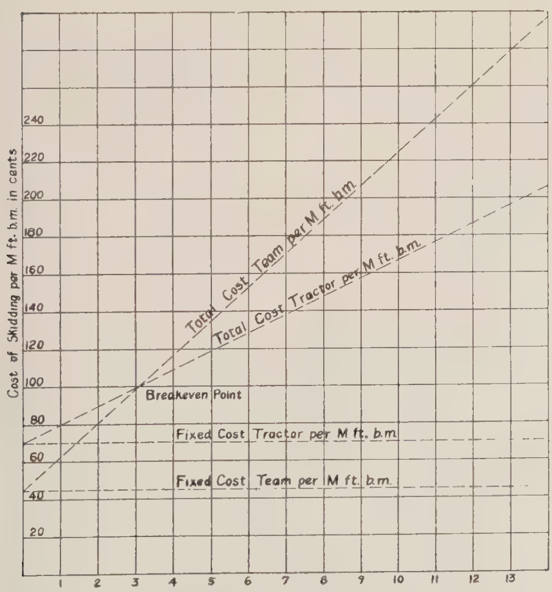

Fig. 1.—Comparative cost of team and tractor skidding. Skidding distance in hundreds of feet.

The higher cost of road construction compels a wider spacing of roads which in turn calls for the use of the tractor.

When 2.5 M feet b.m. only are to be cut per acre, and teams are to be used, costs involved are as follows:

Fixed skidding cost	28 cents per M
Variable skidding cost	18 cents per M per 100 feet
Road construction cost	$750 per mile

Spacing $S = \sqrt{\dfrac{.33 \times 75{,}000}{2.5 \times 18}}$ or 23.4 hundred feet

When tractors are to be used costs involved are:

Fixed skidding cost	43 cents per M
Variable skidding cost	6.8 cents per M per 100 feet
Road construction cost	$750 per mile

Spacing $S = \sqrt{\dfrac{.33 \times 75{,}000}{2.5 \times 6.8}}$ or 38 hundred feet

Costs can be estimated as follows:

	Costs per M feet b.m. Tractor	Team
Fixed skidding cost		$0.28
Variable skidding cost $\dfrac{23.4}{4} \times 18$ cents		1.05
Road construction cost		1.05
Fixed skidding cost	$0.43	
Variable skidding cost $\dfrac{38}{4} \times 6.8$ cents	0.64	
Road construction cost	0.64	
Total	$1.71	$2.38

The high cost of road construction combined with the low volume per acre sets the economic spacing of the roads at such a distance as to make the use of tractors much more economical than the use of teams.

The conclusions to be drawn from the foregoing calculations are that any factors which tend to increase the cost of roads per M feet b.m., such as scattering stands of low volume per acre, difficult topography, and major transport methods which call for expensive roads, also tend to widen the economic spacing of roads; whereupon the tractor, which is most efficient on long hauls, is the best skidding device to use. Conversely, any condition which will lower the cost per M feet b.m. of the major transport system, so that roads can be closely spaced, will tend to favor skidding methods where fixed costs are low even though variable costs per 100 feet of distance are high.

LUMBERING AND FORESTRY IN NEW HAMPSHIRE

By GEORGE M. HOPKINS

New Hampshire Forestry and Recreation Department

The forests of New Hampshire, except those in the northern part of the state, where cutting has been delayed, have been producing a large volume of very poor timber. The outlets for this timber were curtailed with the decline of the wooden box and other wood-using industries. It appears from this study that, because the annual growth exceeds the cut, a quality growing stock might be built up which could meet the present day demands. Because the 1938 blowdown hit hardest in the more mature timber it will take a longer time to build up this quality growing stock.

A SURVEY of the markets for forest products and a study of the trends in lumbering in New Hampshire have brought out some interesting facts. From the time of earliest settlement the woods have been a constant source of fuelwood and building materials. At first, land was cleared for farms, later the forests were cut over for the softwoods which were floated to the ports for export or shipbuilding. With the advent of the sawmill and especially the portable mill more and more of the area was cut until now only a small percentage of the accessible land has not been heavily cut. The production of lumber reached a peak in 1907 and from then declined steadily until 1932. Since then it has been increasing but is still less than 223 million board feet which was the average annual cut for the so-called normal period from 1925 to 1929.

Besides being a valuable resource in themselves the forests contribute to the industrial activity of the state. The wood-using industries are exceeded in importance only by the leather and textile industries with which they are compared in Figure 1. The fact that the wages paid are virtually equivalent to the value added by manufacture, and value of product indicates that little is left for the raw product i.e., stumpage and that the profit from timber growing and operating must be low. These factors are of vital concern to timberland owners since the success of forestry or the planned use of timberlands will depend upon the well being of these industries.

Shipbuilding was the first industry to demand any large volume of forest products. Later the wooden box and lumber industries were the leaders in the consumption of softwoods and furniture manufacturers used most of the hardwood lumber. At present the pulp mills make the biggest demands on the forests.

Wood has largely been replaced in ship building although there is some demand for oak timbers or spruce spars for fishing vessels. The use of wooden containers was reduced by the development of lighter and cheaper cardboard cartons. The furniture and lumber manufacturers have found it impossible to get the quality of timber close enough to the plant so they import sawn lumber for furniture construction and the retail trade.

The forests of New Hampshire are capable of producing the material required by the wood-using industries and even now the estimated annual increment is believed to be more than the volume cut. But if this wood is to be of greatest value the products grown must be those which the industries can use. In the past lumbering has culled the forests to such an extent that there is little timber of any quality left as the basis for a new stand. In the northern part of the state beech, birch, maple, spruce, and fir are the chief species. These are all used for pulp even when they could be used more economically for other purposes. In the southern part of the state where the important species are white pine, hemlock, and red oak and other hardwoods, the situation is even worse. Most of the pine material goes to box shops and these concerns expect to get the "better than box" grade along with the box lumber. There is little effort to separate out the quality material for special uses or to increase its growth in the forest stands.

The present outlets for timber can be put into about five groups: first, fuelwood; second, pulpwood; third, box manufacture; fourth, wholesale lumber; and fifth, the outlets for small amounts of various species to several types of wood-using plants.

The first outlet always has and always will exist. However, there is an opportunity to increase the returns by better marketing and by improving the quality of future increment by

more selective cutting. The demand for quality cleft wood is somewhat limited but it is frequently the most profitable form of utilization. Mixed ungraded hardwood is the mainstay of the fuelwood market but at times there is an excess of such wood cut and prices are low. Often trees that would produce quality logs are cut prematurely for this class of fuelwood. Other than that used by woodland owners the chief consumers of fuelwood are the urban wood dealers and brick yards. It is estimated that the fuelwood cut in New Hampshire in 1937 amounted to over 300,000 cords.

The comparative value of wood for the manufacture of pulp has been fairly well maintained although some of the industries have been in financial difficulties. One advantage of this product is that the producer can get more value into it by cutting and peeling than into logs. This should be an expanding outlet as the demand for cellulose products increases, and one which should be able to utilize poorer quality wood. Most of the 282,000 cords of boltwood cut in 1937 was used for pulp.

Since the war the market for pine boxes has been very poor. As box manufacture continues to be the principal use for native pine in the southern part of the state it has a great influence on the profitable handling of woodlands. The use of wooden containers will probably never regain its former place hence a new use must be found for this grade of pine or something else must be grown in its place if the land is to be used to advantage. Nearly 40 million board feet of New Hampshire lumber was used for the manufacture of wooden containers in 1937.

The production of construction lumber in wholesale amounts is coming back to this section, but since timber of good enough quality is scattered and since western lumber is still cheap the outlet will probably develop slowly. Mills of this type used about 30 million feet in 1937.

The small mills, many of which have been running for nearly a century, offer outlets for small quantities of logs. Usually they do custom sawing as well. Among the products of these mills are lumber for local use, handles, toys, turnings, baskets, crutches, and novelties and specialties of almost every description. Many are run by water power, have few employees and most of them use only 100 to 200 M bd. ft. per year. They have several advantages, including low overhead, closeness to timber supply, and freedom from labor troubles. Some mills in this category have recently been abandoned mainly because the initiative to run them was lacking; in most cases those that have been running were not so badly depressed by hard times as were the larger concerns. In 1937 these mills used over 30 million board feet of logs.

Nearly all the lumbering practices have tended to make the forests less and less productive and therefore the industries ultimately less and less successful. At present there are 4,559,650 acres in New Hampshire classed as forest land which have a valuation of about 95 million dollars. Most of the valuable timber is in the spruce and northern hardwood region north of the lakes district. The stand of timber here is fair and a few virgin areas exist. The proportion of land in forest in the southern part of the state is almost equally great, but the original stands have been removed and the second growth has been cut in most places leaving a variety of conditions, mainly immature stands of white pine and mixtures of sprout hardwoods in which red oak, maple, basswood, and ash are the better species.

In the northern region logging generally removes only the better hardwoods, spruce, and fir. Clear-cutting even on pulp operations is rare because the cull factor is still high. In the southern region so-called "clear-cutting" is frequently practiced. This consists in cutting everything that will make a log 8 or 10 feet long and 6 inches in diameter at the top; following the logging, cordwood is often cut, which removes the best but not all of the remaining hardwood trees. The residual stand of broken and deformed trees then develops into wolf trees over the new crop of sprouts and seedlings.

The problem of handling the forests hinges around economical utilization of poor quality wood which has resulted from such repeated cullings. The practice of cutting everything as soon as it is salable is not a very constructive one. The development of permanent mills which would buy logs or stumpage regularly might encourage more conservative practices. Use of poorer grade softwoods for boxes, etc., and of the poorer hardwoods for fuel must be increased before the forest growing stock can be brought up to the volume and quality that it ought to be. This will involve light selection cuttings to remove inferior trees and to improve the general quality and growth. Such a procedure will be

followed only if reliable markets exist, and the wisdom of conserving promising young timber is realized.

Besides the marketing possibilities the type of ownership will influence the policy of forest management. Very little land is held primarily for its timber producing capacity. Some of the forest areas are owned as parts of farms, summer homes, or estates, some as speculative ventures, some for the recreational value and others for the protection they give to game or water or for the value of minerals, etc. Lumbermen as a rule buy lots and keep them until markets are good enough to make logging them worth-while, after which they abandon or sell them for practically nothing, which (considering the cost of getting a new crop of trees established and paying the taxes until the crop is mature) is more than they are worth. Part of any program to help the forest industries or forest management will be to encourage owners to appreciate the possible value of their lands for timber production and to show them how this value can

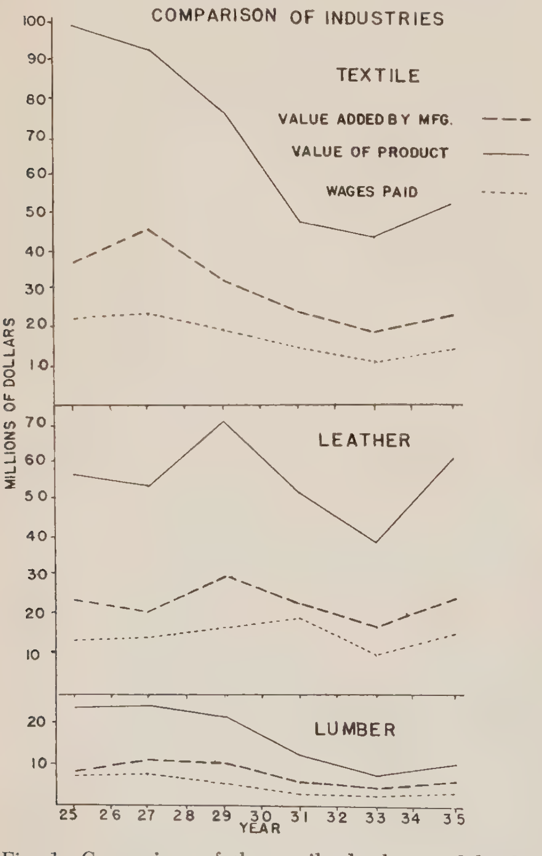

Fig. 1—Comparison of the textile, leather, and lumber industries of New Hampshire.

supplement other values. The public forests should be actual demonstrations of the harmonious use of forest lands to obtain the optimum values. The White Mountain National Forest and some of the state and town forests are now successful examples of this but more of them should be managed more actively with timber production as the major consideration.

Two possibilities suggest themselves for dealing with the lumber situation in New Hampshire. One is to have a large efficiently operated mill in each county or district; the other is to have a large number of small mills scattered throughout the state. In either case management could be cooperative or individual.

The large type of mill is encouraged by the development of truck logging and savings resulting from large scale production. In this case also much more can be done in the line of grading and close utilization. A sawmill and box or cooperage shop can be run conjunctively.

The large mill for each district should come in the future when the forest growing stock has been built up to a point where there is an allowable annual cut of 5 to 10 million bd. ft. within a 15 mile radius. The market for wholesale lots of New Hampshire lumber is uncertain and at present the lower grades and box boards make such a high proportion of the cut that the premium on the quality lumber cannot make up for the losses on the poor grades. There is still the danger of these mills cutting themselves out of quality if not quantity. However, with the return of northeastern lumber upon markets now monopolized by western and southern species, such mills ought to supply the lumber most economically. Large mills are suited to conditions in the northern part of the state where the timber is available. Pulp mills answer the need to some extent but the potential value of the better material is not always realized. Only rarely are better logs saved for lumber or veneer.

Under the present conditions, especially in southern New Hampshire, of isolated mature timber, rough topography, and comparatively poor transportation systems it seems that scattered small industries are the solution to the lumbering problem.

The small mills are well suited to the present conditions. They can produce native lumber for local use in competition with that shipped in from the South or West. They are able to produce a variety of products so that the market

for any one of them need never be flooded. They employ local labor in seasons when other work is short. They can change the type of product without excessive cost or scrapping of expensive equipment. Often they can utilize water power which would be inadequate for larger mills or other industries.

The future success of forestry and lumbering industries in New Hampshire depends upon: 1. Developing means of utilizing poor quality timber. 2. Cutting the poorest timber first in order to increase quality increment. 3. Maintaining small local industries which use small amounts of native lumber until larger demands can be supplied. 4. Gradually increasing the merchantable portion of the forest growing stock. 5. Developing mills which will consume most economically the annual growth when the forests reach more normal stocking. 6. Utilizing all the values of wooded areas.

SUSTAINED YIELD AND TAXES

By T. H. CRAWSHAW and A. B. RECKNAGEL[1]

Taxes, sustained yield, and the weather are subjects widely discussed, but too often not in connection with specific areas. In this article the authors give costs and returns for two typical tracts of timber in the Adirondack Mountains of New York and present their view on taxation policy in relation to permanent forest practice. Can sustained yield solve the tax problem?

In his annual report for 1938, F. A. Silcox,[2] chief of the U. S. Forest Service, states that "Timberland taxation is a problem primarily within the jurisdiction of state and local governments. It may be assumed that they and owners of forest lands will best be protected by taxation so applied as to encourage building up and maintaining forest productivity and continuous returns." He goes on to show that "One difficulty in getting such taxation lies in the widespread policy of quick liquidation."

Two examples of sustained yield management policy which has not contemplated quick liquidation will be cited. Located in the central Adirondack region of New York State, they have been under forest management for a long period. The history of these two areas, which for convenience will be called areas *A* and *B*, is shown in Tables 1 and 2, respectively. These tables offer positive proof that not only no liquidation has been practiced in the past, but that, as a result of sustained yield management for over thirty years, they contain an ample growing stock which is continuously producing valuable timber.

Mr. Silcox next states, "So far, taxing agencies have been inclined to get while the getting was good. This has too often resulted in distress both to owners and to the public." No one will disagree with him in this conclusion. As a matter of fact in the case of six towns in the central and northern part of New York State, four of which are typical forest areas and two of which are preponderantly agricultural, it is estimated that the tax authorities have indeed been "getting while the getting was good." The statistics, contained in Table 3, are very illuminating and will be referred to again.

In this connection, Figure 1 demonstrates graphically the rising cost of taxes on area *B* and is positive proof that the taxing authorities are inclined to place the burden, in an increasing measure, on timberland irrespective of whether such burden can be born equitably. The authors know of flagrant instances where assessed values, too, have been jumped by the assessors to meet the need for increased tax revenue.

Mr. Silcox next raises the point that "Equitable solution of forest land tax problems depends on private owners acting in conformity with the nation's forest policy." It would seem that the owners of areas *A* and *B* have indeed been acting in

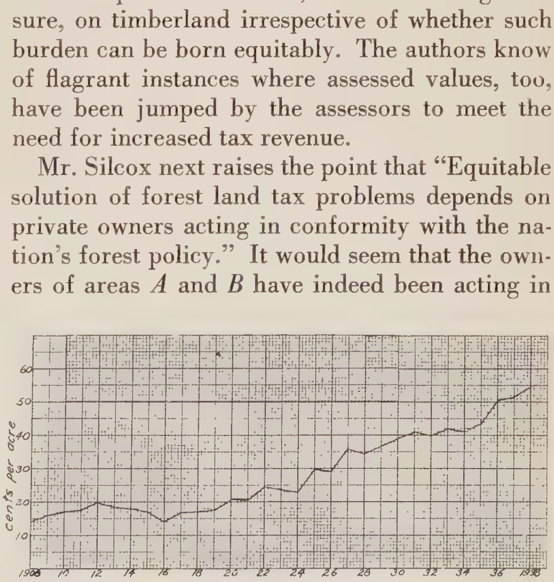

Fig. 1.—The rising cost of taxes per acre from 1908 to 1938 on 18,102 acres of timberland in the central Adirondack region of New York State.

[1]Members, New York Section, Society of American Foresters, Committee on Taxation and Insurance.

[2]Silcox, F. A. Report of the chief of the U. S. Forest Service for the year ending June 30, 1938. U. S. Dept. Agric. 1938.

TABLE 1.—SUSTAINED YIELD MANAGEMENT OF AREA *A* (24,630 ACRES)

Tax Costs of Forest Land in Continuous Private Ownership

For the period 1906 through 1938, $196,426.96 in taxes was paid under sustained yield management. The amount and stumpage value of material cut during these years was as follows (to nearest M):

Species	Volume[1] M ft. b.m.	Value per M[2]	Total value
Spruce	59,763	$4.81	$287,459
Hemlock	15,634	4.81	75,198
Pine	1,108	7.56	8,376
Cedar	146	4.81	701
Hardwood	20	5.00	102
Total	76,671		$371,836

In 1938 the growing stock (of peeled spruce and fir, 5 inches d.b.h. and up) was	79,322 cords
With a c.a.i. of 2.38 percent for 30 years (the cutting cycle), in 1969 the growing stock will be	160,638 cords
Total increment in 30 years	81,316 cords

The annual tax costs on the 24,630 acres as of 1938 are $12,863.31, or $.522 per acre. If these continue at that level during the years 1939 to 1969, taxes will aggregate $385,899.30.

Cutting only the growth, 81,316 cords, in 1969, would cost a total of $385,899.30 in taxes which are equivalent to $4.746 per cord.

Yearly Average Per Acre Costs of Managed Forest Area Under Sustained Yield.

1. Administration, which includes administrative forestry department, and accounting department, surveying, research and cultural measure expenses, association dues, donations, and general expense	$ .15
2. Fire prevention	.01
Total	$ .16
Cost per acre of administration and fire prevention for 30 years	$4.80
Cost of administration and fire prevention for 24,630 acres for 30 years	$118,224
Applying these administration and fire prevention costs to the pulpwood grown in 30 years (81,316 cords), the cost per cord produced is	$1.454
Tax cost per cord for the 30 years is	4.746
Total cost per cord as of 1969	$6.200

Which is higher by 20 cents a cord than any recorded pulpwood sales in the central Adirondack region.

In the event that sustained yield management were abandoned and complete liquidation resulted in cutting all the softwood in 1969 (160,638 cords), the total cost would be $3.138 per cord.

Because the property as a whole is managed on an annual yield basis, the above figures purposely omit all interest charges and rental value of land. Administration and fire prevention costs are low due to the large scale operations of the owners.

[1]Present forest management on the area is for pulpwood primarily which will explain the transition from M feet of saw timber to cords.

[2]Values from Steer, H. B. Stumpage prices of privately owned timber in the United States. U. S. Dept. Agric. Tech. Bull. 626. 1938.

TABLE 2.—SUSTAINED YIELD MANAGEMENT OF AREA *B* (18,102 ACRES)

Tax Costs of Forest Land in Continuous Private Ownership.

For the period 1908 through 1938, $164,433.18 in taxes was paid under sustained yield management. The amount and actual stumpage value of material cut during these years was as follows (to nearest M):

Species	Volume M ft. b.m.	Value per M[1]	Total value
Spruce	47,764	$5.578	$266,438
Hemlock	6,201	5.859	36,329
Pine	3,164	8.239	26,067
Cedar	8	4.50	36
Hardwood	3,533	3.921	13,854
Totals	60,670		$342,724

In 1938 the growing stock (of peeled spruce and fir 5 inches d.b.h. and up) was	64,815 cords
With a c.a.i. of 2.38 percent for 30 years (the cutting cycle) in 1969 the growing stock will be	131,260 cords
Total increment in 30 years	66,445 cords

The annual tax costs on the 18,102 acres as of 1938 are $9,918.19, or $.548 per acre. If these continue at that level during the years 1939 to 1969, taxes will aggregate $297,545.70.

Cutting only the growth, 66,445 cords, in 1969, would cost a total of $297,545.70 in taxes which are equivalent to	$4.478 per cord

Yearly Average Per Acre Costs of Managed Forest Area Under Sustained Yield.

1. Administration, which includes administrative, forestry department, and accounting department, surveying, research and cultural measure expenses, association dues, donations, and general expense	$ .15
2. Fire prevention	.01
Total	$ .16
Cost per acre of administration and fire prevention for 30 years	$4.80
Cost of administration and fire prevention for 18,102 acres for 30 years	86,890
Applying these administration and fire prevention costs to the pulpwood grown in 30 years (66,445 cords), the cost per cord produced is	$1.308
Total tax cost for 30 years	4.478
Total cost per cord as of 1969	$5.786

Which is within 22 cents a cord of the highest recorded pulpwood sale in the central Adirondack region.

In the event that sustained yield management were abandoned and complete liquidation resulted in cutting all the softwood in 1969 (131,260 cords), the total costs would be $2.929 per cord.

The above figures purposely omit all interest charges and rental value of land; administration and fire prevention costs are low due to the large scale operations of the owners.

[1]Values from Steer, H. B. Stumpage prices of privately owned timber in the United States. U. S. Dept. Agric. Tech. Bull. 626. 1938.

conformity with the nation's forest policy. An examination of the statistics in Tables 1 and 2 shows that the growing stock under continuous forest management will produce at the end of 30 years some 80,000 cords, or 3.302 cords per acre on the average for area *A*, and some 66,000 cords, or 3.671 cords per acre for area *B*. To do this successfully involves in both cases an investment by the owners of approximately 15 cents per acre for administration and an additional 1 cent per acre for fire prevention, or a total of 16 cents annually. Although this sum may not seem large, it will aggregate in the 30 years before the crop matures $4.80 per acre, or a total, as shown in Tables 1 and 2, amounting to a large sum. When the cost of administration and fire prevention is added to the tax cost, it becomes evident that the total exceeds what may reasonably be expected in the way of return from the sale of timber at the time of harvesting.

For example, on area *A* the cost, at the end of the cutting cycle or in 1969, will be $6.20 per cord, which is more than has ever been obtained in any sale of record in the Adirondack region. On area *B* the cost will be almost as much, $5.79.

Evidently, therefore, mere conformity to the nation's forest policy by the practice of sustained yield will not result, in the case of these owners, in an equitable solution of their forest tax problems.

Before passing to the next point in Mr. Silcox's report it is well to point out that even liquidation of the two areas would involve high costs: $3.14 per cord in the case of area *A* and $2.93 per cord in the case of area *B*. When current prices of pulpwood in the Northeast are considered, it would seem that liquidation as such holds out little promise of relief. This entirely aside from the disastrous effect on the national economy.

Finally, Mr. Silcox states that "It is inconceivable that owners who approach state and county authorities with a workable plan for sustained yield forest management and who convince those authorities that they can and will operate on such a basis should not get a square deal." It is unfortunately true that the assurance of a "square deal" is by no means so easily attained as the Chief Forester seems to think. Reference to Table 3 will show that, in the case of the forest towns, the taxes have been piled up far beyond what is either necessary or bearable in the absence of corresponding service rendered. It is fair to ask, 'Why should a purely farming community be able to govern 1,452 people at a yearly cost of $15,900 and a forest community of 437 people spend $35,500 a year for government?" Perhaps the answer is found in the inherent conviction of many tax assessors that all timber is a wasting asset and that the taxes thereon should be levied while the timber is still available, or perhaps there are other reasons.

It is not the purpose of this article to suggest how needed reform can be accomplished. The situation on its own merits shows that there must be greater care on the part of the tax officials in assessing property at its fair market value. This is the first necessary step.

The second and equally important step is in controlling expenditures so that there will not be the extravagant outlay from areas which cannot afford them and for purposes which are not justi-

TABLE 3.—COMPARATIVE VALUATIONS OF FOUR REPRESENTATIVE FOREST AND TWO FARM TOWNS[1] IN NORTHERN NEW YORK STATE (1937)

	Forest Towns				Farm Towns	
	1.	*2.*	*3.*	*4.*	*5.*	*6.*
1. Area in acres	150,355	103,644	253,698	162,614	42,996	34,481
2. Population	437	567	1,038	1,120	5,512	1,452
3. Assessed Values[2]						
a. Land only	$544,899	$419,361	$1,866.250	$1,406,357	$1,024,700	$297,670
b. Land and improvements	$676,044	$519,901	$3,125,103	$1,784,292	$4,612,324	$842,247
4. Ratio of assessed value to full value	64	69	55	40	76	64
5. General property taxes (Aggregate)	$67,221	$49,015	$206,586	$102,104	$116,477	$39,641
6. Rate of tax per $1 of assessed value	.0994	.0942	.0661	.0572	.0252	.0470

[1]The above four forest towns represent towns where chief source of revenue is from taxes on forest properties, and the two farm towns are representative of preponderantly agricultural areas.

[2]State of New York, annual report of state tax commission, 1937. Legislative document (1938), No. 11. J. B. Lyon Co., Albany, N. Y. p. 373. 1938.

TABLE 4.—EXPENDITURES IN REPRESENTATIVE FOREST AND FARM TOWNS IN NORTHERN NEW YORK STATE (1937)
(These are the same towns as in Table 3)

Forest towns	Population	Cost of government[1, 2] Total[3]	Per capita
1.	437	$35,500	$81.24
2.	567	28,900	50.97
3.	1,038	76,000	73.22
4.	1,120	34,500	30.80
Farm towns			
5.	5,512	56,900	10.32
6.	1,452	15,900	10.95

[1]Cost of government includes compensation, fees, and expenses of supervisor, town councilmen, town clerk, justices of the peace, assessors, receiver of taxes, town attorney, town hall expenses, rent of rooms, advertising, printing, election expenses, bond issue expenses, and insurance. It also includes protection of persons and property, conservation of health, sanitation, highways, public welfare, emergency relief, library, recreation, cemeteries and interest on temporary loans.

[2]State of New York, Special Report of state comptroller on municipal accounts. Legislative Document (1938) No. 13. J. B. Lyon Co., Albany, N. Y. p. 358. 1938.

[3]To nearest $100.

fied. Table 4 gives figures for six forest and agricultural towns in the area under consideration, showing the expenditures for general government. Other statistics are available showing the high cost per pupil in the schools of the four first towns—costs at almost collegiate levels.

No one will quarrel with the need for education, and all reasonable care should be given so that the standards of education and of transportation are observed in towns preponderantly forest as well as in towns preponderantly agricultural. However, it is obviously out of line when a farming community can conduct its affairs so much more economically than a forest community and when the tax rate and the per capita expenditures are so much lower in the farm community than in the forest community.

In conclusion, if sustained yield management of forests is not to be penalized and enforced liquidation avoided, there must be immediate tax relief. Unanswered by Mr. Silcox remains the question, "How can a square deal come to pass while forest land taxes are mounting?" Perhaps the answer will be found in a genuine attempt to practice economy. This will go far towards reducing expenditures, but it alone will not suffice. The assessing of forest property at its fair market value is not adequately covered in procedure under the tax law. There is need for further study based on the experience of private owners who have been practicing forest management for many decades.

Nothing has been said in this article as to the intangible values which are being maintained on areas, such as those cited, due to sustained yield management. It is demonstrably true that these intangible values far exceed any values in dollars and cents which accrue to the general public from the taxes themselves.

After all, when the part which forests play in controlling floods, in preventing erosion, in conserving moisture, and in maintaining wildlife, and when all the other multiple values of an adequate timber supply are taken into consideration, it is evident that it is clearly to the interest of the public not to lose forest values which are maintained and increased through the practice of sustained yield management on private timberland, but to assist the owner in his efforts to perpetuate the forest resource.

DEAR PROFESSOR RECKNAGEL:

Thanks for your letter of April 7, and for copy of "Sustained Yield and Taxes."

It's an interesting paper and presents, it seems to me, a good argument for reduction of taxes and—from the viewpoint of the owner of Tracts *A* and *B*, at least—for reduction also in costs, volume, and perhaps character of local government. Frankly, though, I don't see that the examples referred to have much connection with the excerpts quoted from my annual report.

I know personally of a number of owners who have gotten a square deal under the circumstances to which my report refers, but I'm not, of course, naive enough to believe that such a deal will drop into the lap of any one owner, or every owner, merely because he is complying with the nation's forest policy. Neither, I am sure, do you. Nor—from your paper—is liquidation the answer with respect to these two tracts, at least. So what?

One answer is to revise current general practices with respect to taxation of forest lands, of course. And—although there may be exceptions, including Tracts *A* and *B*—I still believe that conformity by owners with the nation's forest policy will, by and large, help secure "equitable solution" of the tax problem.

I have no disposition to quarrel with you about the showing with respect to Tracts *A* and *B*, and the desirability of tax adjustments there. I can't help but wonder, however, if consideration should

not be given to certain points not discussed in your paper.

You speak, for example, of a ceiling of $3 per cord for current stumpage prices for pulpwood. According to Steer's bulletin—to which you refer—there is no close correlation between stumpage prices and the real worth of stumpage. I wonder if the raw material on these tracts has ever been evaluated in terms of the values of the finished product to the company? Isn't this—rather than going price for stumpage—what really counts?

I also wonder if the company can get an assured future supply of pulpwood for less than what it is now costing on Tracts *A* and *B*? If so, it may be poor business to hang onto these tracts under present tax conditions. If not, it may be good business. In other words, stumpage on these tracts may be worth more than the current ceiling, even though it's only $3 per cord.

It seems to me points like these may well have a very definite bearing on the company's policy with respect to Tracts *A* and *B*. In fact answers to them might well indicate that the company is justified in continuing sustained yield management in face of the present tax situation, and even though that situation might not change.

Thanks again for your letter and for your manuscript. I appreciate your thoughtfulness in sending them to me.

F. A. Silcox,
Chief, Forest Service.

Cost of Planting a Tree On Plains Under 6 Cents

The entire cost to the federal government of this year's planting of field windbreaks in the Prairie States Forestry Project is being kept to about 5¾ cents a tree or shrub, the U. S. Forest Service reports. More than 42,000,000 trees in 4,500 miles of windbreaks were planted in 1939. This cost includes investments in and depreciation of equipment, seed collection, rodent control, and planting and care of about 70,000,000 seedlings and transplants now growing in nursery beds.

The government supplies the trees, labor, and supervision, and farmers invest an equal amount by furnishing the land, fencing material, and labor in preparing the land and cultivating the young trees during the first few years of growth.

Cost of the prairie tree planting work is carried by W.P.A. funds and all labor is furnished from W.P.A. relief rolls. Technical and administrative supervision is by the Forest Service.

The 1939 plantings brought the total since 1935 to more than 127,000,000 trees in over 11,000 miles of field windbreaks on 20,000 farms in eastern counties of the Dakotas, central and western Nebraska, central Kansas and Oklahoma, and the Texas panhandle.

THE EFFECT OF LENGTH OF DAY ON THE HEIGHT GROWTH OF CERTAIN FOREST TREE SEEDLINGS

By JOSEPH R. JESTER[1] AND PAUL J. KRAMER[2]

Although considerable experimental work has been done on the effect of length of day on the growth, flowering, and fruiting of agricultural and horticultural plants, comparatively little work has been done on the effect of length of day on forest trees. The results reported here of work done at Duke University have important technical implications. For instance, they show that slash pine, shortleaf pine, jack pine, and beech can be thrown out of their normal growing rhythm by long days; but the normal period of growth of other species such as chestnut oak and southern red oak is not readily changed.

It has been generally assumed that low temperature is the most important factor in determining the length of the growing period of many plants. The results of certain recent investigations, however, indicate that length of day or photoperiod may be equally important. An investigation was therefore conducted of the effects of various lengths of day on the length of growing season and height growth of several species of trees.[3] Four coniferous species of different geographical distribution were chosen to determine whether trees from northern and southern latitudes having different lengths of day during the growing season would react to various photoperiods in the same manner. Coniferous species investigated were Norway pine (*Pinus resinosa* Ait.) and jack pine (*P. banksiana* Lamb) which have a northern range, shortleaf pine (*P. echinata* Mill.), which is intermediate in range, and slash pine (*P. caribaea* Morelet) which has a southern range; deciduous species included chestnut oak (*Quercus montana* Willd.), southern red oak (*Q. rubra* L.), black locust (*Robinia pseudoacacia* L.), beech (*Fagus grandifolia* Ehrb.), and red maple (*Acer rubrum* L.).

Garner and Allard (*5, 6*), Laurie and Poesch (*13*) and others have shown that the time of flowering and fruiting, and amount and nature of vegetive growth of certain herbaceous species, were affected by different photoperiods. Ramaley (*17*), Gevorkiantz and Roe (*7*), Garner (*4*), and Hamner (*8*) have summarized the literature on this subject, consequently no complete review will be made.

Klebs (*10*) reported that European species of ash, beech, oak, and hornbeam grew all winter under continuous light. Garner and Allard (*6*) working with apple, yellow poplar, box elder, winged sumac, and smooth sumac found that box elder grew better with a 10-hour day than with normal long midsummer days. By supplementing daylight with electric light until midnight, yellow poplar grew all winter, smooth sumac made no growth but retained its leaves all winter, while the leaf fall of winged sumac was retarded only a few weeks. They concluded, therefore, that the photoperiod is probably important in determining the beginning and end of the dormant period. Adams (*1*) reported that dormancy of sugar maple was not broken earlier by lengthened photoperiods. Moshkov (*15, 16*) reported that tree species from southern Russia, such as *Robinia pseudoacacia* and *Salix babylonica* L., when grown in Leningrad where the maximum length of day is 20 hours, continued to grow in the autumn until they were killed by frost, but by artificially shortening the photoperiod dormancy could be brought on before frost. He found that the morphology of Robinia was altered by the length of the photoperiod. With short days it branched less, formed scales instead of thorns, and produced fewer pairs of leaflets. Bogdanov (*2*) also found that cold resistance and the length of growing period were affected by photoperiod. Gevorkiantz and Roe (*7*) concluded from Russian work that stem length, branching habit, leaf surface area, bud activity, leaf fall, and root development may be affected by the length of day. Matzke (*14*) found that Carolina poplar (*Populus canadensis* var. *eugenei* Schelle.), London plane (*Platanus acerifolia* Willd.), sycamore (*Platanus occidentalis*

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[1]U. S. Plant Introduction Garden, Glenn Dale, Md.

[2]Department of Botany, Duke University, Durham, N. C.

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L.), and crack willow (*Salix fragilis* L.) growing near street lights retained their leaves later in the autumn but did not leaf earlier in the spring. Kramer (*11*) observed that potted seedlings of yellow poplar, black locust, red gum, northern red oak, post oak, white oak, loblolly pine, beech, and white and green ash became dormant as soon in a warm greenhouse as out-of-doors, although most species retained their leaves longer in the greenhouse. He found that all species, other than the ashes and red oak, made better height growth and grew later in the autumn when daylight was supplemented by artificial light to give a 14½-hour photoperiod. Red gum and yellow poplar grown with short day made less height growth and became dormant sooner than with normal day. He also found that with a 16-hour day yellow poplar grew all winter, while red gum grew nearly all winter. Under continuous light both species grew all winter. Loblolly pine grew all winter with a 14½-hour day, but made better growth under a continuous light. In the same investigation Kramer found that resumption of growth following a dormant period was hastened in yellow poplar, beech, red gum, and red oak by additional light and was retarded by a photoperiod shorter than normal. In a later investigation Kramer (*12*) found that black locust and *Abelia grandiflora* exposed to electric lights out-of-doors grew until killed by frost.

Methods

All seedlings used in this investigation were started from seed and were allowed to germinate in the part of the greenhouse allotted to them for photoperiod treatment. The slower germinating seeds were planted a month before the pine and black locust seeds in an attempt to get simultaneous germination. Several pine seeds were planted in each 8-inch pot to assure two seedlings that could be carried through the entire observation period. The seeds of deciduous species were planted in 6-inch pots, but only one seedling was kept per pot. The seedlings for the out-of-doors experiments were started in the greenhouse and moved out-of-doors.

The various photoperiods were started after the seed had germinated. Height growth was recorded as soon as the seedlings appeared to be well established. These seedlings were grown in the greenhouse under four photoperiods:

(1) Continuous day—obtained by supplementing daylight with artificial light.

(2) Long day—obtained by supplementing daylight with sufficient artificial light to obtain a 15-hour photoperiod.

(3) Normal day—varying in the latitude of Durham, N. C., from about 14½ to about 9½ hours.

(4) Short day—obtained by screening the seedlings with black cloth that could be pulled over a frame constructed seven feet above the floor, thus making a light-tight compartment. This compartment was closed at 4:45 p.m. every day and opened the following morning at 8:15 a.m., giving an 8½-hour photoperiod, approximating the shortest days of midwinter.

Seedlings were grown out-of-doors under two photoperiods:

(1) Normal day.

(2) Long day—obtained by supplementing daylight with sufficient artificial light to obtain a 15-hour photoperiod.

The artificial light for both continuous and long day was provided by 100-watt, 115-volt light bulbs. The lights could be adjusted and were kept from two to three feet above the tops of the seedlings. The light intensity at the soil surface was about 20 foot-candles. The lights used for the long day were operated automatically by a time switch.

The temperatures in the various parts of the greenhouse that were assigned to the several photoperiods varied slightly, but this variation between places was never over 2° C. The temperature of the places assigned to the outside photoperiods also varied, but the variation between places never exceeded 3° C. The seedlings, both inside and outside the greenhouse, were watered several times a week to assure adequate soil moisture.

Height growth of the seedlings was taken from the tops of the pots to make certain that all measurements would be taken from the same level. All heights are given in centimeters of growth from the top of the pot to the tip of the tallest shoot. Heights were taken and recorded at intervals of two weeks. The data for each treatment are based on measurements of ten to fifteen trees.

The experiments extended over approximately two years, including parts of three growing seasons. The black locust seedlings were so large at the end of one year that they were discarded and a new series started from seed. The continuous day series was discontinued for all species at the end of the first year, and most of the plants were transferred to long day treatment.

An analysis of variance was made on these data to separate the gross variation into the variation between photoperiods and the variation within photoperiods. The significant variation between photoperiods is that variation which is caused by the effect of the treatment, and which is therefore of greatest interest. The variation within photoperiods is due to differences between trees of the same species and is therefore regarded as error. Analyses of variation were made for height growth of the first growth period, total height growth for the entire observation period, length of growth periods, and length of dormant periods for species investigated. If a significant difference appeared between the photoperiods, a *t* test was applied to test the significance of differences between individual photoperiods. The results of the investigation are summarized in Table 1 and are shown graphically in Figures 1 to 7. The graphs show the behavior of certain species not included in Table 1. They also show the variation in length of growing season with various photoperiods.

Discussion

The results of this investigation indicate that there are significant differences in length of growing period and amount of height growth of some species, and that these differences are closely related to length of day. Inspection of Table 1 shows that short days significantly retarded the height growth of black locust, slash pine, red maple, and chestnut oak, but not that of southern red oak. Long days caused increased height growth in black locust, slash pine, and red maple. but did not significantly affect southern red oak, while chestnut oak made less growth with long day than with normal day. Out-of-doors, long day caused increased height growth in black locust, red maple, southern red oak, and chestnut oak, but no significant difference in slash pine. Continuous light in the greenhouse caused black locust, slash pine, red maple, and chestnut oak seedlings to make even more height growth than with long day, but did not significantly affect height growth of southern red oak.

Table 1.—Significant Differences in Mean Height Growth for Entire Observation Period[1]

Photoperiod	Species	Short dav inside	Normal day inside	Long day inside	Normal day outside
Normal day inside	Black locust	more			
	Slash pine	more			
	Red maple	more			
	Southern red oak	ns			
	Chestnut oak	more			
Long day inside	Black locust	more	more		
	Slash pine	more	more		
	Red maple	more	more		
	Southern red oak	more	ns		
	Chestnut oak	more	less		
Normal day outside	Black locust	more	ns	less	
	Slash pine	more	more	less	
	Red maple	more	more	ns	
	Southern red oak	less	less	less	
	Chestnut oak	ns	less	less	
Long day outside	Black locust	more	more	more	more
	Slash pine	more	more	less	ns
	Red maple	more	more	more	more
	Southern red oak	more	ns	less	more
	Chestnut oak	more	less	ns	more

Legend

less = significantly less growth with the photoperiod indicated on the left than with that indicated over the vertical column.

more = significantly more growth with the photoperiod indicated on the left than with that indicated over the vertical column.

ns = no significant difference in amount of growth. A difference is regarded as significant if the odds are 100 to 1 against it resulting from chance.

[1]These comparisons are based on one growing season for black locust, two growing seasons for slash pine, and three growing seasons for the other species.

It would be expected that a significantly lengthened growing season would be accompanied by a significant increase in height growth. This was true of all species investigated except slash pine out-of-doors which grew all winter, but which was soon overtaken in the spring by the normal-day trees.

It is interesting to observe that the oaks did not behave the same indoors as out-of-doors. Southern red oak, which did not have its growth increased by a lengthened day indoors, grew significantly more out-of-doors. Chestnut oak, which made less growth with long day than normal day indoors, had its growth increased significantly when grown out-of-doors. This may have been partly caused by the fact that the temperature was usually higher in the greenhouse than out-of-doors. As shown most recently by Roberts and Struckmeyer (*19*) variations in temperature may in some species considerably change the response to a given photoperiod. Further investigation of the oaks seems desirable since both species had very short growing seasons and measurements two weeks apart may not have been frequent enough to record small differences in length of their growing seasons. Garner and Allard (*6*) found that a certain variety of apple grew more with short days than with long days. This may also have been caused partly by interaction between temperature and photoperiod. Kramer (*11*) found that white and green ash were not affected by variation in length of day, or, if so, that the proper combination of photoperiod and temperature had not been tried.

Beech, Norway pine, and jack pine grew all winter in the greenhouse with continuous day, but only jack pine grew all winter with long day. The mean height growth fell off considerably when continuous day was changed to long day (May 24, 1936). These results along with the failure to obtain the survival of beech, jack pine, and Norway pine grown with normal days and short days possibly may be explained by the inability of these seedlings to maintain a satisfactory respiration-photosynthesis ratio with temperatures that were much higher than those of their native habitat. Burns (*3*) in a discussion of minimum light requirements brought out the fact that the respiration-phyotosynthesis coefficient could be less than one, equal to one, or more than one, depending upon the amount of carbon dioxide produced in respiration in proportion to that used in photosynthesis. He therefore concluded that the respiration-photosynthesis coefficient would have to be less than one for a plant to survive and that this was affected by increases in light intensity if other factors remained constant. It seems possible that the northern species grown out of their range may have a respiration-photosynthesis coefficient that is greater than one because of the disproportional increase of respiration over photosynthesis. The high night temperature of this region may have resulted in an excessive proportion of the products of photosynthesis being used in respiration, leaving an insufficient quantity for growth. Further investigation of the respiration-photosynthesis coefficient of tree seedlings grown with various photoperiods should be useful in explaining the very interesting problem of why northern species moved South do not grow vigorously, even though they may survive.

None of the morphological changes reported by Moshkov (*15*) were observed in these experiments. The trees which made more growth with long days or continuous light were merely larger than the controls, but not otherwise changed. They appeared to be just as sturdy and their leaf color was as good as in the normal day trees. No anatomical studies were made although they might yield interesting results.

All the deciduous seedlings grown in the greenhouse retained their leaves several weeks longer than those grown outside with the same photo-

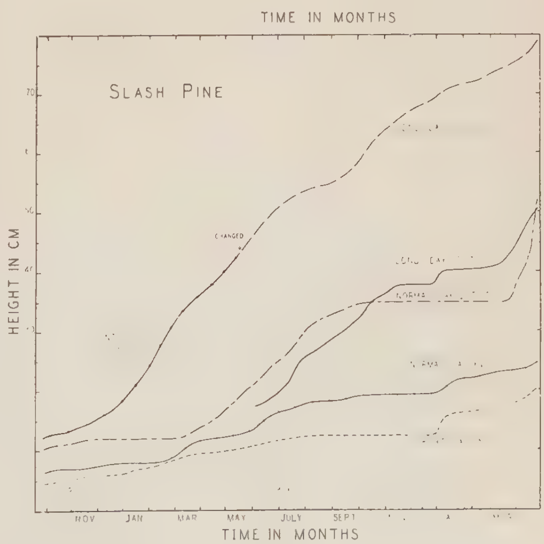

Fig. 1.—Height growth of slash pine with various photoperiods. The continuous day trees were changed to long day in May 1936.

period. All but one red maple seedling grown with continuous light retained many of their leaves from the first growing period through the entire observation period. This one seedling, which was near a broken pane in the greenhouse, lost its leaves at the end of the first growing period. It is possible that the cold air to which this seedling was exposed caused the formation of a more pronounced abscission layer. Red maple seedlings grown with long day outside lost their leaves much sooner than those grown inside with the same photoperiod, thus indicating that, while temperature may not be the only factor in the formation of an abscission layer, it does play an important part. It would be interesting to investigate other deciduous species that retain their leaves all winter in the greenhouse to see if various photoperiods would have any effect on their leaf fall.

Although the data from these experiments, as shown in Figures 1 to 7, indicate that length of day seems to control the length of growing season of certain species of tree seedlings it should not be regarded as the direct cause or the only factor

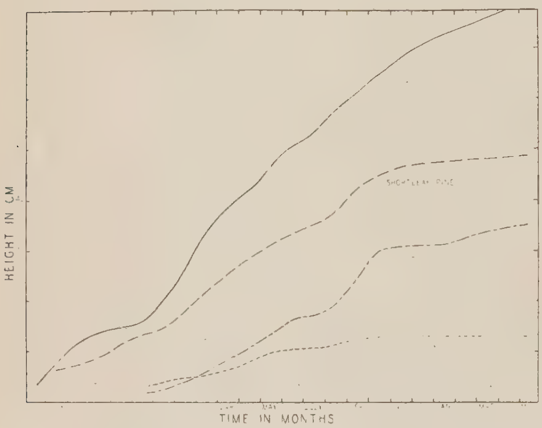

Fig. 2.—Height growth of four species of pine grown in the greenhouse with continuous light which was changed to long day in May. Seedlings of Norway and jack pine failed to survive with normal and short days.

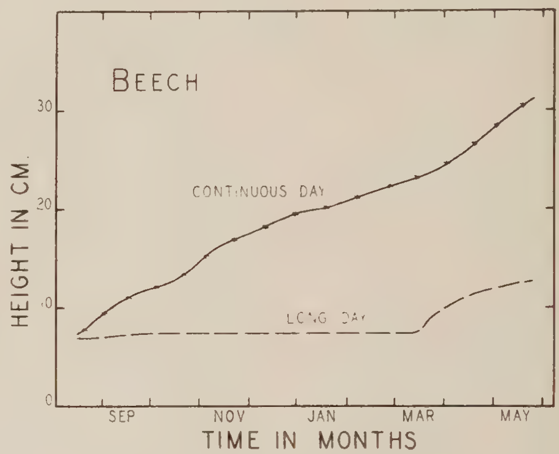

Fig. 3.—Height growth of beech grown in the greenhouse with continuous and long day. Beech seedlings failed to survive with normal and short days.

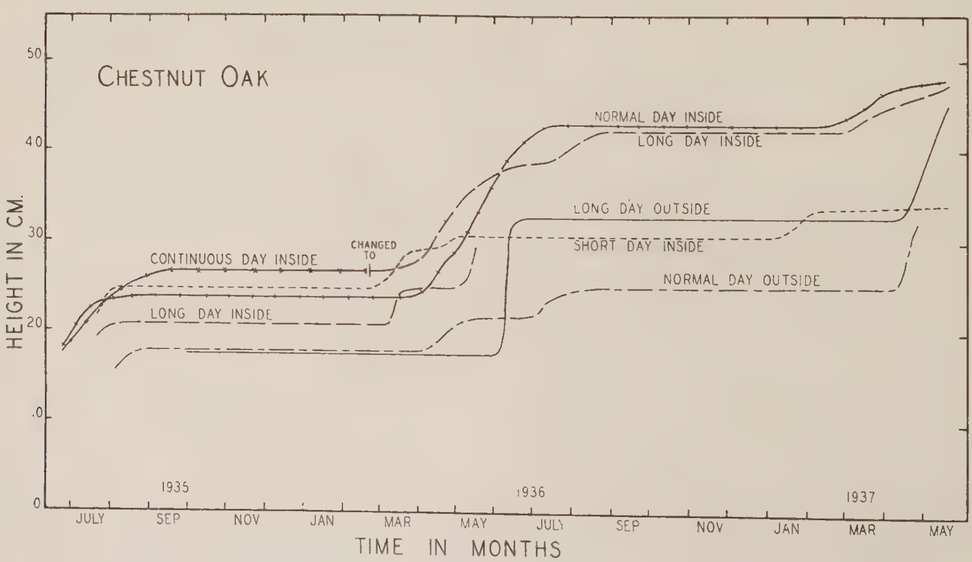

Fig. 4.—Height growth of chestnut oak grown with various photoperiods.

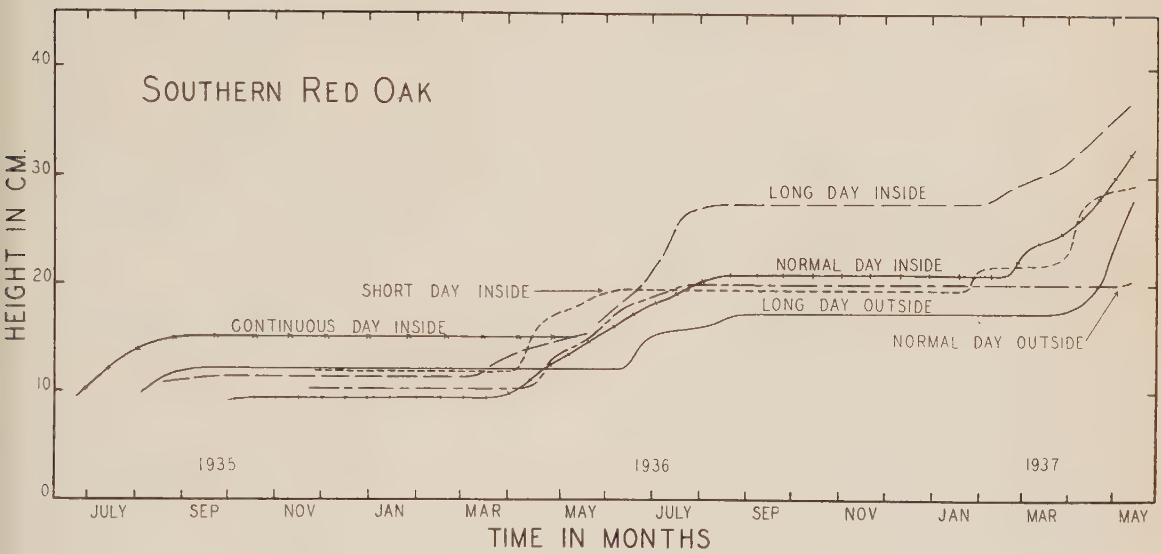

Fig. 5.—Height growth of southern red oak grown with various photoperiods.

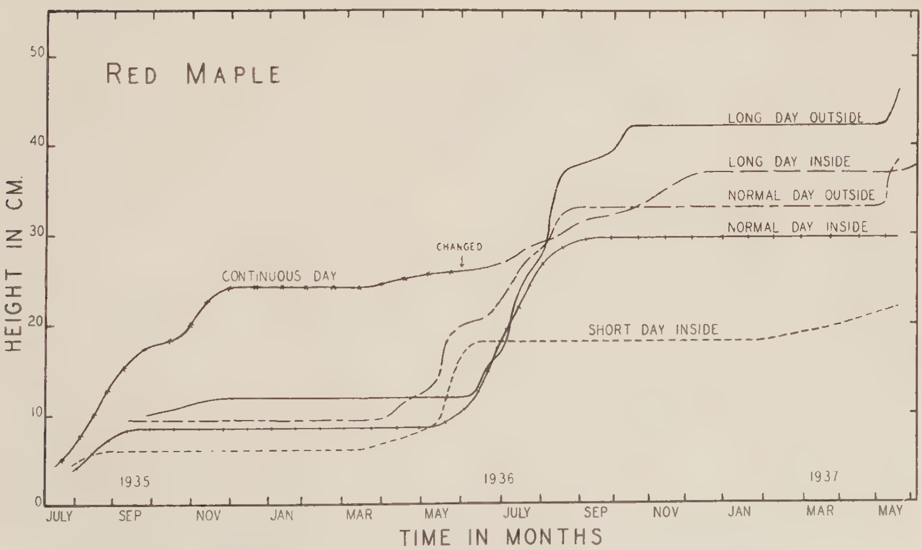

Fig. 6.—Height growth of red maple grown with various photoperiods.

involved. As pointed out earlier by Kramer (*11*), changes from the growing to the dormant condition and vice versa, like other growth phenomena, are the direct result of changes in the internal physico-chemical processes and conditions of the protoplasm. Within the limits of the hereditary potentialities of any particular species such changes in internal processes and conditions may be brought about by one or several environmental factors acting singly or in combination. Among the factors which are known to affect the length of the growing season are variations in temperature, soil moisture, and the supply of mineral nutrients, especially nitrogen. Length of day seems more important than any other factor in some of the species investigated, but Roberts (*18*) and Roberts and Struckmeyer (*19*) have shown that even response to length of day can be modified by nitrogen supply and temperature.

It seems that information concerning the responses of tree species to various lengths of day may be useful in a number of ways. It may at least partly explain the latitudinal distribution of certain species as well as why different species growing in the same region have growing seasons of different lengths. Use of electric lights to lengthen the growing season and increase the amount of growth made by seedlings of certain species in the nursery might be practical in some circumstances. Growing (nondormant) seedlings of some species can also be made available in midwinter for teaching and research by lengthening the photoperiod with electric light.

Summary

1. Black locust, slash pine, red maple, and southern red oak seedlings in the greenhouse made significantly more height growth with long day than with normal length of day. Chestnut oak made significantly less height growth with long day than with normal length of day.

2. Black locust, red maple, southern red oak, and chestnut oak seedlings out-of-doors made significantly more height growth with a 15-hour day than with normal length of day. Slash pine out-of-doors grew during the entire winter with long day, but it did not make significantly more height growth for the entire period than with normal length of day. Black locust grew out-of-doors until killed by frost.

3. Black locust, slash pine, red maple, and chestnut oak seedlings in the greenhouse made significantly more height growth with continuous light than with long day. Southern red oak showed no significant increase in height growth with continuous light.

4. With continuous light slash pine, Norway pine, jack pine, shortleaf pine, beech, red maple, and black locust grew all winter in the greenhouse.

5. A significantly lengthened growing period was accompanied by a significant increase in height growth in all species investigated except slash pine growing out-of-doors.

6. Slash pine, red maple, black locust, and chestnut oak seedlings in the greenhouse made significantly less height growth with short day than with normal day. Southern red oak showed no significant difference.

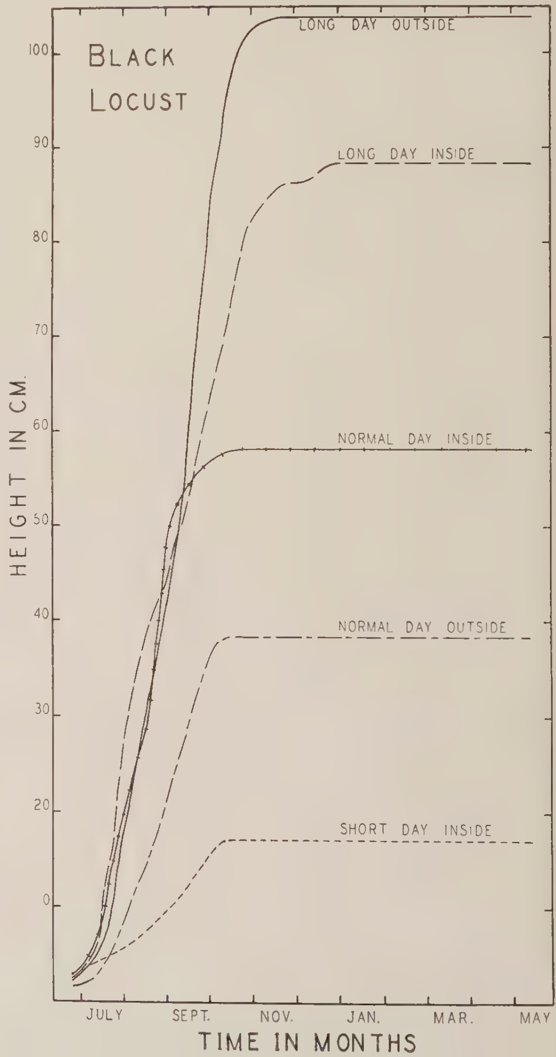

Fig. 7.—Height growth of black locust grown with various photoperiods.

7. Beech, red maple, southern red oak, black locust, and chestnut oak, both inside and outside the greenhouse, retained their leaves longer with continuous and long day than with normal length of day. Red maple, grown with continuous day inside, retained most of its leaves from the first growing period for the entire observation period of almost two years. There also was a tendency for all the deciduous species to retain their leaves longer in the greenhouse than outside.

8. Beech, Norway pine, and jack pine, all of which are northern species, made better growth with continuous day than with long day, and were not successfully grown with normal or short days.

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VARIATION IN RAINFALL OVER SHORT DISTANCES[1] AT THE CLOQUET FOREST EXPERIMENT STATION

By T. SCHANTZ-HANSEN and R. M. BROWN

University of Minnesota

In the older European forestry literature there are many references to the influence of forests on rainfall. Rain gauges were established in forests and in contiguous open areas. Higher catches of rainfall in the forests were interpreted as showing that forests increase rainfall. A statistical analysis of the rainfall catches in the forest and in open areas in northern Minnesota indicates that variations in rainfall as large as 30 or 40 percent, but still having no statistical significance, occur within short distances. Consequently, the older data on the influence of forests on rainfall should be used only with the greatest circumspection if indeed they should be used at all.

UP TO the present time, little attention has been given to variations in rainfall during the same storm over short distances in interpreting the results of silvicultural or other experiments involving the use of plots. Many studies have been made of the effect of elevation and type of gauge on the catch. Laskowski (*7*) showed that over a period of five years a gauge located on the ground at Topeka, Kansas, recorded 9 percent more rainfall than a gauge located on the top of a six-story building only seventeen blocks away. Kadel (*6*) found that a gauge with a funnel 6 inches deep caught 1 1/6 percent more rainfall than a gauge with a funnel 2¼ inches deep. Furthermore, the variation between the two gauges was greatly affected by wind velocity. He concluded, however, that the standard 8-inch gauge used at present is sufficiently accurate. Carter (*2*) at Lincoln, Nebraska, showed that a delay in measuring rainfall for even as much as twelve hours meant a total loss for the growing season of the equivalent of from 0.3 to 0.6 of an inch of precipitation.

Although these illustrations show that differences in elevation, type of gauge, and the time of reading introduce variations into the recorded catch, local variations in rainfall intensity during the same storm, however, may be partly responsible for the differences obtained. For example, Humphrey (*5*) cites the work done in New South Wales by Musson, who studied the rainfall distribution over a mile-square area by means of 47 gauges located in the shape of a cross. In this study he found a variation of 30 percent between gauges. In a somewhat similar experiment Humphrey studied the distribution of rainfall at the Desert Laboratory in Arizona by placing 24 gauges in 4 rows at 100-meter intervals. During a year's observation, he found considerable variation between the gauges; but the variation was not consistent nor did it follow a definite pattern. The greatest variation occurred during heavy storms.

The study of the microclimate is important not only in drawing conclusions from silvicultural, but also from protection, grazing, or other investigations based on sample plots. For example, because the various environmental factors determine the rate of growth, the variations introduced into these factors by thinnings or other cultural operations must be known before reliable conclusions may be drawn. Rainfall is one of the most important of these environmental factors. Obviously, the quantity falling on a stand is not affected by any cultural operations, but the amount that actually reaches the ground and thus becomes available for growth may be affected considerably. Mitchell (*8*) found that 78 percent of the rainfall reached the ground through a jack pine stand and 82 percent through a hemlock-hardwood stand. Furthermore, he found that a larger percentage of the total rainfall reached the ground during heavier storms. Beal (*1*) in Canada reports that 60 percent of the rainfall reached the ground through a Norway and jack pine stand and 80 percent through a hardwood stand. These studies show that the character and density of the crown also have an appreciable effect upon the amount of rainfall reaching the ground.

During the growing season of 1933 and 1934 the changes in environmental factors after thinning jack pine were studied at the Cloquet Forest Experiment Station (*4*). One heavily thinned, one moderately thinned, and one unthinned stand were studied.

Among other things, rainfall reaching the

[1]Published as Journal Series Paper 1450, University of Minnesota Agricultural Experiment Station.

ground was measured under each of the three crown canopies. These data are given in Table 1. Theoretically, the amount reaching the ground should be least in the unthinned stand, slightly more in the moderately thinned, and greatest in the heavily thinned stand.

TABLE 1.—MONTHLY PRECIPITATION REACHING THE GROUND UNDER JACK PINE OF VARIOUS DENSITIES

Month	Unthinned 1933	Unthinned 1934	Moderately thinned 1933	Moderately thinned 1934	Heavily thinned 1933	Heavily thinned 1934
July	2.17	1.75	2.15	1.77	2.33	1.70
August	.81	1.61	.92	1.73	1.05	1.72
September	3.00	2.11	3.38	2.28	3.13	2.73
Total	5.98	5.47	6.45	5.78	6.51	6.15
Percentage of Unthinned	100	100	108	106	109	112

Although the totals in Table 1 indicate that the rainfall reaching the ground increases with a decrease in crown density, are these differences large enough to warrant such a conclusion? To test whether these differences are larger than mere chance variations, Fisher's *(3)* analysis of variance was used. The results are given in Table 2.

TABLE 2.—ANALYSIS OF VARIANCE

Source of variation	D. F.	Mean square	F
Between thinnings	2	0.063	2.4
Between months	2	3.233	124.4[1]
Between years	1	.132	.5
Thinnings and years	2	.004	.1
Months and year	2	1.008	38.8[1]
Error	8	.026	
Total	17		

[1]Very highly significant. The value of F at the 5 percent level of significance is 4.5 and at the 1 percent level 8.6.

As shown in this table, the variation from month to month and from year to year was statistically eliminated from the comparison between thinnings. Since the value of F, 2.4, for between thinnings is much less than the value of F at the 5 percent level of significance, these differences are purely accident; and, in so far as these data are competent to show, the conclusion cannot be drawn that the rainfall reaching the ground increased with the degree of thinning.

Even though the heavily thinned stand showed 12 percent more rainfall reaching the ground than the unthinned stand, it is not significant.

Individual storms showed considerable variation from the theoretical trend. During 1933. 23 storms of measurable precipitation occurred. In two storms the rainfall at all three stations was the same; in 12 the trends were normal, and in 9 they were abnormal. If the 2 storms with equal fall are considered abnormal, 50 percent of the storms did not show the expected trend. In 1934, data for 44 additional storms were obtained. Of these, two were equal at the three stations, 18 were normal, and 24 abnormal. No apparent explanation for this variation other than local variation suggests itself.

Obviously, in order to interpret properly the differences in the rainfall reaching the ground in the thinning experiment, it is necessary to know whether the microclimate of the different plots varies by more than sampling differences. To check this, four rainfall stations were established in 1935. Two of these were located 100 yards apart in the center of a 14-acre cleared field. The third station was located in the center of a four-acre cleared field two hundred yards from the fourth station, which was the regular U. S. Weather Bureau cooperative station. A 60-year old stand of jack pine is between Stations III and IV. Stations III and IV are approximately a half-mile from Stations I and II.

Standard U. S. Weather Bureau 8-inch gauges were used. The depth of the funnel was the same, thereby eliminating that source of variation. Furthermore, all gauges were at the same distance above the ground, and at practically the same elevation. In order to eliminate any variation due to evaporation, the rainfall was measured immediately after each storm. Table 3 gives the rainfall records for 22 storms that occurred during July, August, and September of 1935.

These figures again show differences, but are they significant? Although by inspection it is obvious that the grand totals are not significantly different from a practical standpoint, the differences were tested by the analysis of variance; and, as expected, turned out to be not significant.

Had the differences in the thinning experiment turned out to be significant, it is likewise obvious that the foregoing test would have shown that all the plots were subjected to the same microclimate; and, therefore, the comparisons and conclusions would have been more valid.

Table 3.—Precipitation Recorded on Four Comparable Stations, 1935

Date	Station I	Station II	Station III	Station IV
	Inches	*Inches*	*Inches*	*Inches*
July 11	1.13	1.16	1.14	1.10
14	.18	.17	.12	.12
18	1.00	.94	1.00	.96
18	.02	.02	.02	.02
19	.72	.69	.71	.72
27	1.83	1.79	1.80	1.80
30	.03	.03	.02	.03
Total for July	4.91	4.80	4.81	4.75
Aug. 2	.11	.12	.14	.13
5	.09	.09	.13	.13
5	.49	.50	.48	.49
9	1.20	1.34	1.60	1.12
17	.16	.14	.13	.11
18	.05	.05	.06	.04
20	1.21	1.20	1.20	1.19
23	.02	.02	.02	.02
24	1.06	1.07	1.08	1.07
25	.26	.26	.25	.25
27	.08	.08	.06	.05
30	.17	.17	.15	.14
Total for Aug.	4.90	5.04	5.30	4.74
Sept. 3	.35	.35	.38	.38
12	1.04	1.00	1.01	.96
26	.27	.26	.24	.24
Total for Sept.	1.66	1.61	1.63	1.58
Total for the season	11.47	11.45	11.74	11.07

Because the rainfall at these stations is not significantly different, some idea of the distribution of the relative differences within the same storm can be obtained from these data. The distribution of these percentages, using Station I as a standard, is shown in Table 4.

These rainfall figures show that within these 22 storms, roughly ½ of the percentages exceeded 10 percent; about 1/6 exceeded 20 percent; 1/7 were more than 30 percent; and 3 percent were 40 percent or more. Most of these large percentage variations, however, represent actual differences that are of no practical significance; and in most cases they are large because the rainfall is small. This distribution of percentages does show that since deviations as large as 30 or 40 percent that are not significant can be expected within short distances, it is hazardous to draw conclusions without statistical tests. Furthermore, it is likewise obvious that statistical tests of the microclimate should be included in the interpretation of data from sample plots separated by even short distances.

Table 4.—Distribution of Relative Deviations[1]

Deviation	Number of differences	Percentage of total
Percent		
0—5	38	57.6
6—10	7	10.6
11—15	5	7.6
16—20—	5	7.6
21—25	1	1.5
26—30	1	1.5
31—35	6	9.1
36—40	1	1.5
41—45	2	3.0
Total	66	100.0

[1]If a table similar to Table 4 but based on a large number of storms were compiled by the Weather Bureau, it could be used to test the significance of differences in rainfall.

Eventually sufficient rainfall data of this type will be available for the Cloquet Station to show whether variations in microclimate can be dismissed, or must be taken into consideration in the design of the experiments and in drawing conclusions from experimental plots.

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PRELIMINARY YIELD TABLES FOR SELECTIVELY CUT STANDS OF PONDEROSA PINE IN THE BLACK HILLS

By E. M. HORNIBROOK

Rocky Mountain Forest and Range Experiment Station

Preliminary yield tables have been prepared for the intensively used stands of ponderosa pine in the Black Hills of South Dakota and Wyoming. These tables are of interest for two major reasons: first, because they indicate approximate yields in a region known to many foresters as the scene of the first Forest Service timber sale and, second, because mensurationists will be interested in the methods employed, which in one or two variations are unique.

PREDICTION of yield for a given period of time by one method or another is essential to the preparation of any workable forest management plan. Of the methods which can be employed to determine yield the most accurate involves long term observation of permanent sample plots. Unfortunately, however, it is not always practical to await the results of recurrent observations of sample plots and an alternate method which brings forth immediate results must be employed.

Urgent need for immediate results necessitated use of a short-cut method in predicting yield of ponderosa pine in the Black Hills of South Dakota and Wyoming, and the system of reconstructing stands and growth by study of increment cores taken systematically from sample trees was adopted. Whereas this method has inaccuracies foreign to the sample plot approach, it does not require a long period of time to arrive at a more or less well founded estimate of yield. Tables of yield developed by increment core studies and as presented here can be checked, of course, by long time observations.

Field Data

Increment cores and growth data were secured from trees on 65 one-acre plots located in stands that had been cut selectively from 5 to 45 years previously. Good, medium, and poor sites were represented equally, and within each site class plots were selected to represent light, medium, and heavy volumes. The volume of the reserve stand at time of cutting was obtained by reconstructing diameters on the basis of increment core measurements and heights on the basis of growth data collected from felled trees. Volumes (Scribner) were based upon diameters inside bark and total height in feet with the limit of merchantability set at 10 inches d.b.h. and 8 inches at the top. In order to estimate mortality the volume of all standing dead trees, and of those that had fallen over brush piles, logging debris and skid trails, was determined—a procedure involving some error but providing the most accurate measure available. These trees represented mortality since cutting, and their volume was added to the computed reserve volume of living trees to give the initial reserve volume. Any growth made by trees between time of cutting and their death was ignored.

Trees in the reserve stand were classified according to a modification[1] of Keen's tree classification[2] in order to determine stand structure, or the ratio of the percent of reserve volume contained in trees of the most rapidly growing age and vigor classes to the total reserve volume. Tree classes 1A, 1B, 2A, 2B, and 3A were determined to be the classes with greatest potential growing capacity.

Site index curves (Fig. 1) were based upon total height and total age of vigor-class B trees of the modified classification, these being in the dominant class and fairly plentiful.

Analysis

In the analysis and computations, the yield of each plot between the date of cutting and time of measurement was used as a single observation.

It was assumed that the most important factors influencing the yield of plots were the initial reserve volume, the elapsed time since cutting, site, number of poles in the reserve stand which in time may enhance yield by growing into the merchantable size-classes, and stand structure, with the first two being the most important. To deter-

[1]Hornibrook, E. M. A modified tree classification for use in growth and yield studies and timber marking in Black Hills ponderosa pine. Jour. Forestry 37: 483-488. 1939.

[2]Keen, F. P. Relative susceptibility of ponderosa pine to bark beetle attack. Jour. Forestry 34:919-927. 1936.

mine the influence of these factors two separate multiple correlations were performed by the method of least squares involving in one instance volume and the first three variables, and in the other volume and the first four variables. In order to obtain linear relationships between the dependent and the chosen independent variables, all numerical data in the correlations were expressed in terms of logarithms. The logarithmic regression equations, which resulted and which proved to be essentially linear, were used as the basis for constructing the charts which express yield. For a final yield chart the influence of number of poles and the stand structure was incorporated as a correction factor by determining their effect on the relationship of the deviation of the estimated yield from the actual yield of each plot.

In the multiple correlation performed where the dependent variable was logarithm of yield in board feet and the independent variables were (a) logarithm of initial reserve volume and (b) logarithm of number of years since cutting, the correlation coefficient obtained was + 0.8223 and the coefficient of determination was 0.6762, the latter indicating that 67.62 percent of the variation[3] in yield per acre was associated with variation in initial reserve volume per acre and number of years since cutting. This means that 32.38 percent of the variation in yield was associated with factors not included in this analysis such as site, and experimental error which includes variation in mortality among the plots.

Following this correlation analysis a yield chart was constructed from the logarithmic regression equation and the yield of each of the 65 sample plots was estimated from the chart and compared with the actual yields. This comparison indicated that the yields estimated from the chart were 5.36 percent low in the aggregate so the chart was adjusted following methods described by Meyer.[4] After this adjustment (Fig. 2) a second estimate was made and compared with the actual yields with the result that the aggregate deviation and average percentage deviation of yield was 0.19 percent and 27.5 percent, respectively. This means that the aggregate difference between total actual and total estimated yield was 0.19 percent and that the average error of estimating the yield of individual acres was 27.5 percent.

To secure added accuracy in the prediction of yield the second multiple correlation was performed incorporating a third independent variable, logarithm of site index. In this instance the multiple correlation coefficient obtained was +0.8732 and the corresponding coefficient of determination was 0.7625. This indicated that 76.25 percent of the variation in yield per acre was associated with variations in the three independent variables used. The inclusion of the third independent variable, site index, served to increase the multiple correlation coefficient from + 0.8223 as obtained in the first analysis to + 0.8732 in this instance, and their corresponding coefficients of determination from 0.6762 to 0.7625, respectively. An additional 8.63 percent of the variation in yield per acre was accounted for by including site, leaving only 23.75 percent of the variation unaccounted for.

From a yield chart (Fig. 3) constructed from the logarithmic regression equation derived from the second correlation a comparison of estimated and actual yields for each plot was made resulting in an aggregate deviation and average percentage deviation of 3.3 percent and 23.7 percent respectively.

Correction factors.—In analyzing the contribution to volume made by number of poles reaching merchantable limits it was found that only those poles in vigor classes A and B were related to yield. Therefore, by determining the volume of poles in these classes and applying a correction factor to the total yield the accuracy of the estimate was improved. Also a correction factor applied for stand structure served to increase the accuracy of the estimate. Numerically the application of these correction factors reduced the difference between the total actual yields and the total estimated yields of all plots to only 0.46 percent and the average percentage error involved in estimating the yield of individual acres was decreased to 21.3 percent.

Mortality.—The average annual mortality per acre of trees 10 inches d.b.h. and larger was determined to be 28 board feet. The standard deviation, however, was 128 percent of the average,

[3]In discussing correlations in this paper the word *logarithm* is often omitted for the purpose of clarity and brevity. When both the variations in yield and the relationships between the dependent and independent variables are indicated, reference is really made to: (1) variations in logarithm of yield and (2) the relationship between the logarithm of the dependent variable and the logarithms of the chosen independent variables.

[4]Meyer, Walter H. A method of constructing growth tables for selectively cut stands of western yellow pine. Jour. Forestry 28:1076-1084. 1930.

which indicates the extreme variation encountered.

Predicting Yield

A knowledge of the site and the quantity, kind, and condition of reserve stands on selectively cutover areas immediately after logging is fundamentally necessary to the most accurate prediction of future yields and to ascertain whether a given area will be ready for a second cut at the end of various cutting cycles. These data can be determined by inventories of cutover stands which should be made within a year after cutting. At present, however, these data are not available in every instance so examples are presented which indicate methods of predicting yield from both a simple timber inventory and from an inventory designed to secure adequate information for the most accurate results.

Yield prediction based upon a simple stand inventory.—To predict the yield of selectively cut areas on which the timber stand inventory does not include data on site, stand structure, and number of poles, the three variable yield chart (Fig. 2) should be used as follows: Locate the initial reserve volume per acre on the left hand scale of the alinement chart, locate the length of the desired cutting cycle on the right hand scale; with a straightedge span these two points and read the average net yield per acre where the straightedge intersects the middle scale. For example, if a stand has a reserve volume of 2,500 board feet per acre in trees 10 inches d.b.h. and larger the average net yield per acre for a 60-year period is 6,250 board feet.

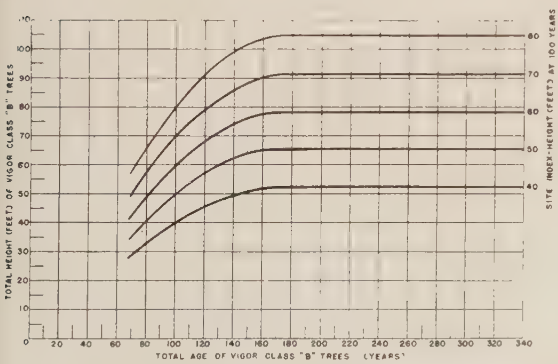

Fig. 1.—Site index curves for ponderosa pine of the Black Hills of South Dakota and Wyoming. Reference age: 100 years.

Yield prediction based on a complete stand inventory.—To predict the yield of selectively cut stands when site index, stand structure, and number of poles of A and B vigor in the reserve stand are known, the second yield chart (Fig. 3) should be used as follows: Locate the reserve volume on scale A of the alinement chart and the length of the desired cutting cycle on scale B; span these two points with a straightedge and mark the point of intersection on the nongraduated scale C; hold the straightedge on the marked intersection on scale C and locate the site index on the right hand side of the chart, scale D; then with the straightedge spanning the two points on scales C and D, read the unadjusted net yield where the straightedge intersects scale X. To adjust the yield obtained from the alinement chart for variations which are associated with stand structure and number of poles with A and B vigor in the reserve stand, enter Table 1 with the values for these factors as calculated from the stand inventory and determine the correction factor; then multiply the estimated yield secured from the chart by the percentage correction factor and add or subtract the product, according to the sign of the correction factor, to the estimated yield obtained from the chart.

For example, if a cutover stand has a residual volume of 4,000 board feet per acre in trees 10 inches d.b.h. and larger, with a site index of 53, a stand structure of 35 percent and 14 poles per acre in the A and B vigor classes, the unadjusted yield in 35 years would be 6,800 board feet as determined from Figure 3. Correcting this figure by +4.8 percent (Table 1), 326 board feet should be added to obtain an adjusted average net yield of 7,125 board feet per acre.

Discussion

The method of constructing the yield charts presented differs from the usual method in that they are based upon linear regression equations derived from multiple correlations. These correlations express the combined importance of the selected independent variables and provide a measure of the variation in yield not associated with these variables. Mortality was added to the reserve volume of living trees to obtain a more accurate total initial reserve volume so that the yields estimated are average net yields and the errors of prediction represent errors of estimating net yield. Consequently no deductions need

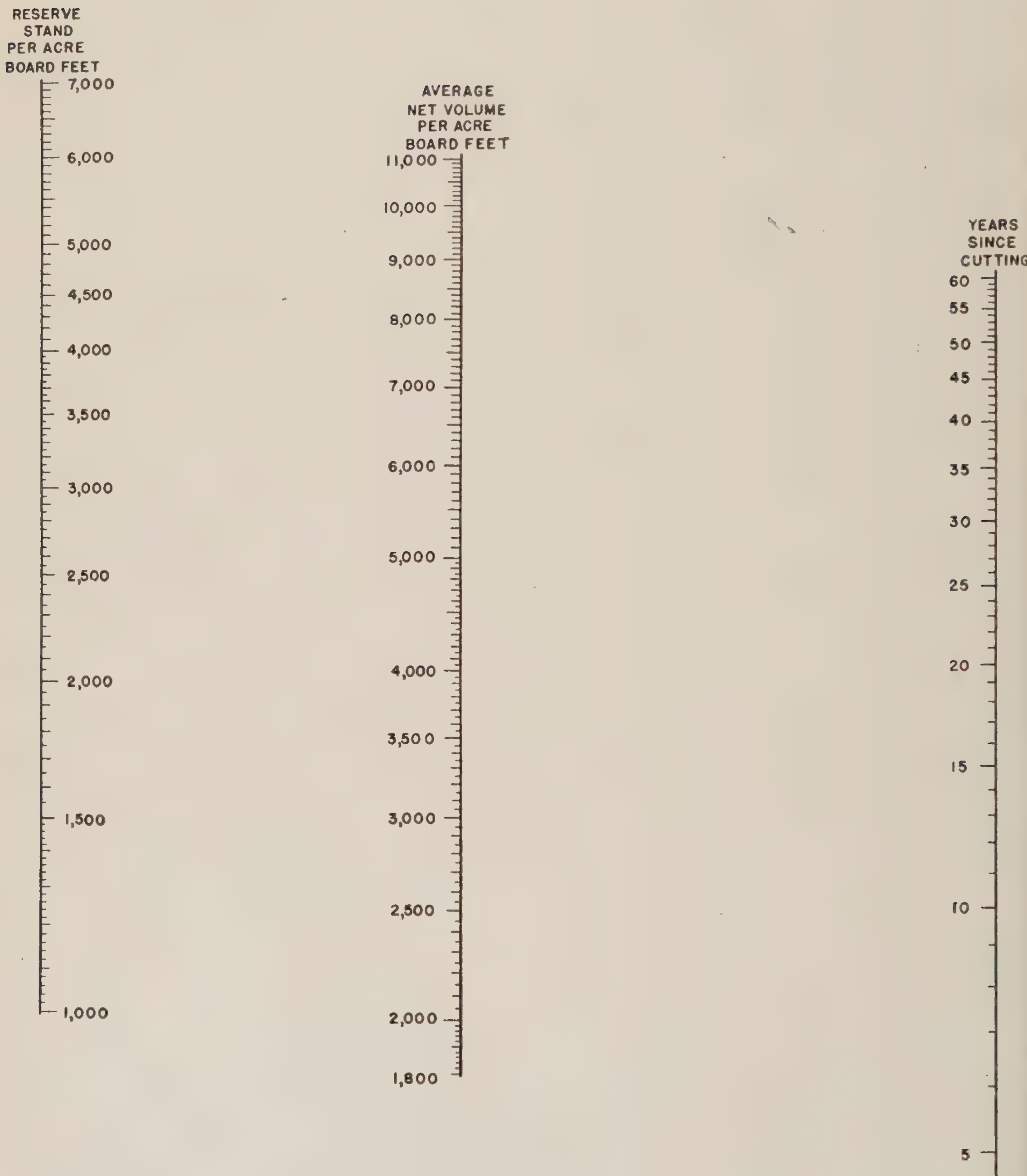

Fig. 2.—Preliminary alinement chart for determining future yield in selectively cut stands of ponderosa pine in the Black Hills of South Dakota and Wyoming.

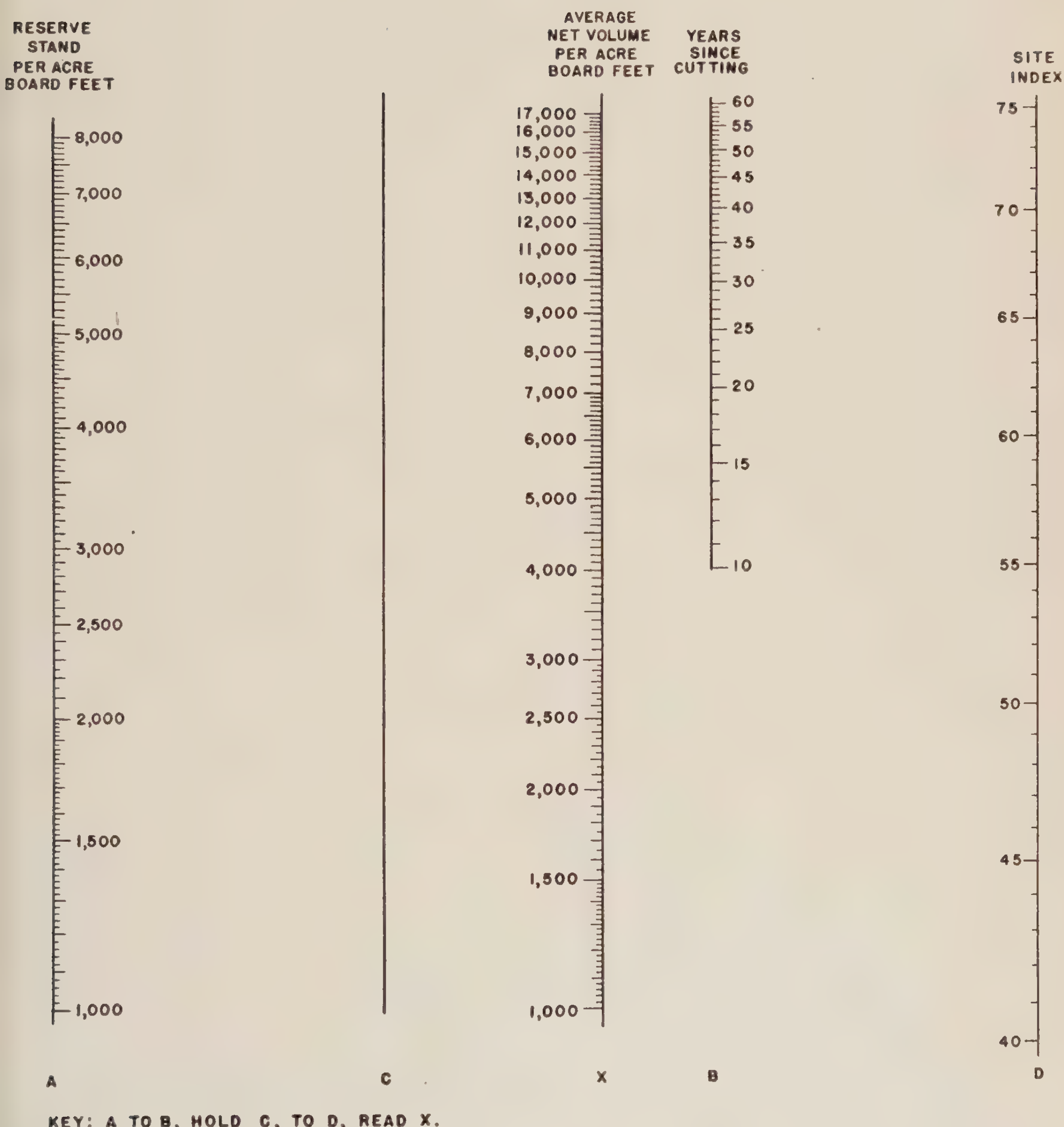

Fig. 3.—Preliminary alinement chart for determining future yield in selectively cut stands of ponderosa pine in the Black Hills of South Dakota and Wyoming.

be made for mortality as the net yield values include average mortality with respect to length of time since cutting, reserve volume, site and stand structure.

TABLE 1.—CORRECTION FACTORS, IN PERCENT, FOR NUMBER OF POLES PER ACRE IN VIGOR CLASSES A AND B AND FOR STAND STRUCTURE

Number of poles with A and B vigor	Stand structure: Percentage of total reserve volume (board feet) composed of age classes 1A, 1B, 2A, 2B, and 3A																
	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
								(*Percent*)									
0	—8.1	—6.6	—5.0	—3.4	—1.8	—0.2	+1.4	+2.9	+4.5	+6.1	+7.7	+9.2	+10.8	+12.4	+14.0	+15.6	+17.2
2	—7.9	—6.3	—4.7	—3.1	—1.5	+0.04	+1.6	+3.2	+4.8	+6.4	+7.9	+9.5	+11.1	+12.7	+14.3	+15.8	+17.4
4	—7.6	—6.0	—4.4	—2.8	—1.3	+0.3	+1.9	+3.5	+5.1	+6.6	+8.2	+9.8	+11.4	+13.0	+14.5	+16.1	+17.7
6	—7.3	—5.7	—4.2	—2.6	—1.0	+0.6	+2.2	+3.7	+5.3	+6.9	+8.5	+10.1	+11.6	+13.2	+14.8	+16.4	+18.0
8	—7.0	—5.5	—3.9	—2.3	—0.7	+0.8	+2.4	+4.0	+5.6	+7.2	+8.8	+10.3	+11.9	+13.5	+15.1	+16.6	+18.2
10	—6.8	—5.2	—3.6	—2.0	—0.5	+1.1	+2.7	+4.3	+5.8	+7.4	+9.0	+10.6	+12.2	+13.8	+15.3	+16.9	+18.5
12	—6.5	—4.9	—3.4	—1.8	—0.2	+1.4	+3.0	+4.5	+6.1	+7.7	+9.3	+10.9	+12.4	+14.0	+15.6	+17.2	+18.8
14	—6.2	—4.7	—3.1	—1.5	+0.1	+1.6	+3.2	+4.8	+6.4	+8.0	+9.6	+11.1	+12.7	+14.3	+15.9	+17.5	+19.0
16	—6.0	—4.4	—2.8	—1.2	+0.3	+1.9	+3.5	+5.1	+6.7	+8.2	+9.8	+11.4	+13.0	+14.6	+16.1	+17.7	+19.3
18	—5.7	—4.1	—2.6	—1.0	+0.6	+2.2	+3.8	+5.4	+6.9	+8.5	+10.1	+11.7	+13.2	+14.8	+16.4	+18.0	+19.6
20	—5.4	—3.9	—2.3	—0.7	+0.9	+2.4	+4.0	+5.6	+7.2	+8.8	+10.4	+11.9	+13.5	+15.1	+16.7	+18.3	+19.8
22	—5.2	—3.6	—2.0	—0.4	+1.1	+2.7	+4.3	+5.9	+7.5	+9.0	+10.6	+12.2	+13.8	+15.4	+17.0	+18.5	+20.1
24	—4.9	—3.3	—1.7	—0.2	+1.4	+3.0	+4.6	+6.2	+7.7	+9.3	+10.9	+12.5	+14.1	+15.6	+17.2	+18.8	+20.4
26	—4.6	—3.1	—1.5	+0.1	+1.7	+3.3	+4.8	+6.4	+8.0	+9.6	+11.2	+12.7	+14.3	+15.9	+17.5	+19.1	+20.6
28	—4.4	—2.8	—1.2	+0.4	+1.9	+3.5	+5.1	+6.7	+8.3	+9.8	+11.4	+13.0	+14.6	+16.2	+17.8	+19.3	+20.9
30	—4.1	—2.5	—0.9	+0.6	+2.2	+3.8	+5.4	+7.0	+8.5	+10.1	+11.7	+13.3	+14.9	+16.4	+18.0	+19.6	+21.2
32	—3.8	—2.2	—0.7	+0.9	+2.5	+4.1	+5.6	+7.2	+8.8	+10.4	+12.0	+13.6	+15.1	+16.7	+18.3	+19.9	+21.4
34	—3.6	—2.0	—0.4	+1.2	+2.8	+4.3	+5.9	+7.5	+9.1	+10.6	+12.2	+13.8	+15.4	+17.0	+18.6	+20.1	+21.7
36	—3.3	—1.7	—0.1	+1.4	+3.0	+4.6	+6.2	+7.8	+9.3	+10.9	+12.5	+14.1	+15.7	+17.2	+18.8	+20.4	+22.0
38	—3.0	—1.4	+0.1	+1.7	+3.3	+4.9	+6.4	+8.0	+9.6	+11.2	+12.8	+14.4	+15.9	+17.5	+19.1	+20.7	+22.3
40	—2.8	—1.2	+0.4	+2.0	+3.6	+5.1	+6.7	+8.3	+9.9	+11.5	+13.0	+14.6	+16.2	+17.8	+19.4	+21.0	+22.5

NOTE: Determine the total percentage of reserve volume per acre in tree classes 1A, 1B, 2A, 2B, and 3A. This percentage indicates which vertical column to use. Determine the number of poles (3.6 d.b.h. to 9.6 d.b.h.) per acre in vigor classes A and B. This number indicates which horizontal column to use. Where the columns intersect read the correction factor in percent.

REPRODUCTION OF SHORTLEAF PINE FOLLOWING MECHANICAL TREATMENT OF THE SEEDBED

By O. M. WOOD

Allegheny Forest Experiment Station

Very often, comparatively simple silvicultural or soil treatments are all that is needed successfully to regenerate a stand. In shortleaf pine-oak mixtures on the coastal plain of New Jersey, the mechanical breaking up of the turf to expose the mineral soil resulted in the establishment of a good stand of seedlings. Removing the litter only by raking was not found to be effective.

ON THE better soils of the New Jersey coastal plain, shortleaf pine occurs occasionally in pure stands but more often in stands mixed with oak. A characteristic of the older stands is the scarcity of pine reproduction in the understory even when the percentage of pine in the old stand is high.

Shortleaf pine in this region does not bear heavy seed crops annually. The last heavy crop occurred in 1927 but there have been partial crops in some years since then, notably in 1936. Hence lack of seed cannot be entirely responsible for the scarcity of reproduction.

Shortleaf pine is known to reproduce well in this region where the soil has been disturbed. In the summer of 1936 a study was begun in the Lebanon Experimental Forest, Burlington County, N. J., to measure the effects of deliberately disturbing the seedbed. A Latin square of sixteen 1/10-acre plots was established within an 80-year-old stand of shortleaf pine. Four of the plots were left undisturbed, four were raked free of surface litter, the humus layer of four more was thoroughly dug up with grading hoes, and from the final four the turf-like humus layer was scalped and removed from the plot. The raking exposed no mineral soil, digging exposed mineral soil over about 50 percent of the treated area, and the scalping exposed mineral soil over the entire area treated.

Ten mil-acre quadrats were staked out systematically within each 1/10-acre plot for observation of natural reproduction. Two quadrats, 3 by 6 feet, were established near the center of each 1/10-acre. One of each pair was screened against animals and the other left unprotected; both were artificially sown with 200 seeds of shortleaf pine in November 1936, when seed was falling naturally.

Pine reproduction in both sets of quadrats was observed weekly from May through September of the following year, and a final examination was made October 11, 1937.

RESULTS

Natural reproduction.—The number of seedlings starting by plots (10 mil-acres) and treatments (40 mil-acres) is shown in Table 1. The number of seed trees (pines 4 inches d.b.h. and up) within each plot is also shown.

TABLE 1.—SEED TREES AND NATURAL SEEDLINGS STARTING, BY PLOTS AND TREATMENTS

Treatment	Seed trees	Seedlings starting	Seed trees	Seedlings starting	Seed trees	Seedlings starting	Seed trees	Seedlings starting	Totals: Seed trees	Totals: Seedlings starting	Totals: Seedlings acre basis
Control	11	3	13	4	12	2	14	7	50	16	400
Raked	8	2	10	3	23	8	10	4	51	17	425
Dug	14	8	11	12	14	18	13	7	52	45	1,125
Scalped	23	34	12	21	5	13	18	17	58	85	2,125
									211	163	

Reproduction was poorest in the controls, little better in the raked plot, nearly three times better in the dug plot, and over five times better where the turf was removed completely. Three factors might account for these results: more abundant seed falling on the latter plots, less destruction of the seed by animals and birds, and greater favorableness of the seedbed.

As for the first, the table shows how well the Latin square design tends to average the irregularities of seed tree distribution in the old stand. Although the number of seed trees per 1/10-acre plot varied from 5 to 23 the totals for each group of 4 plots only varied from 50 to 58. A statistical test was made to determine if the slightly greater number of seed trees in the dug and scalped plots might not account for the greater number of seedlings there. When the number of seedlings was adjusted to a common number of seed trees there were still differences between the treatments. To determine if these differences were real, Fisher's method of analyzing variance and covariance was used. These tests showed that raking resulted in no significant increase in pine reproduction, in contrast to digging and scalping, which did.

Artificial seeding.—The results from the artificially seeded quadrats are shown in Table 2. Since some of these quadrats were screened, while others were not, these results throw light on the second factor affecting the number of seedlings which start.

Table 2.—Seedlings starting in artificially seeded quadrats, by plots and treatments

									Totals	
Treatment	Screened	Unscreened	Screened	Unscreened	Screened	Unscreened	Screened	Unscreened	Screened	Unscreened
Control	21	0	6	0	5	0	12	13	44	13
Raked	7	1	20	12	39	1	45	0	111	14
Dug	42	21	32	29	41	9	35	16	150	75
Scalped	63	19	45	3	20	0	48	1	176	23
									481	125

In the screened plots, where any differences in germination may reasonably be attributed to seedbed conditions alone, the trend is much the same as in the naturally reproduced quadrats; that is, the poorest reproduction was in the control plots and the best in the scalped plots. In this case raking also had an effect, although not as great as the other treatments. Among the unscreened plots those dug gave the best results. Because the seedbed area sampled is less than 1/25th as great as that from which the natural reproduction was measured, the results may be considered less reliable.

The striking thing to note in Table 2 is the great difference in number of seedlings in the screened and unscreened plots. In 15 out of 16 cases more seedlings started within the screened quadrats than outside and the total number of seedlings within the screened quadrats was almost five times as great as the number outside. A statistical test showed that this difference was highly significant. A comparison of the ratios between seedlings starting within and without the screens on different seedbeds suggests that digging or scalping produces an environment unfavorable to seed-eating rodents. Scalping produces a smooth surface which, theoretically at least, exposes surface-sown seed to foraging birds; concentration of seed in a small area, as on the 3 by 6-foot quadrats, may be especially attractive to birds.

Seedling survival.—During the first season (May to October 1937) 83, or more than half of the seedlings which started in the naturally seeded quadrats, died. Death of about 32 percent of these was ascribed to drought, 18 percent to insects, 7 percent each to damping off and insolation, 4 percent each to other fungi and birds, 2 percent to mechanical injuries, one percent to animals, and 24 percent to unknown causes.

In June 1938, the quadrats were again examined. At this time the number of survivors in the natural quadrats had decreased to 30, or only 18 percent of the original number which started. The cause of this additional loss could not be determined; in some cases the seedling had disappeared entirely, in other cases it was found but bore no evidence of injury. In the artificially seeded quadrats 19 and 22 percent of the original number starting in the screened and unscreened, respectively, were alive. Seedbed treatment had no discernible effect on seedling survival.

Prolonged effect of the treatment.—New, or 1938, seedlings were tallied in all quadrats in June 1938. Although the 1937 seed crop was inferior to that of 1936, 17 seedlings were found in the scalped plots and 13 in the dug plots. Only 6 each were found in the raked plots and in the controls. The four seedbeds thus ranked in the same order as in 1937, although the differences between them were less. Apparently the effect of scalping and digging had not been entirely destroyed by erosion and the fall of new litter.

Conclusions

The above experiment, which of course needs repetition in different stands and in different years, indicates that reproduction of shortleaf pine in southern New Jersey may be encouraged to start under old stands by scalping off the turfy layer or by thoroughly digging it up. The former exposes the most mineral soil and is the most effective. Removing the litter only by raking is not effective. Regardless of seedbed treatment, animals destroy a large amount of the pine seed. A high percentage of the seedlings which start fail to survive the first year.

In spite of these losses it is not unreasonable to conclude that if a cheap mechanical method for breaking up the turf were available, and if this method could be applied preceding a really good seed year such as promises to occur in 1938, adequate reproduction of shortleaf pine might be established at reasonable cost under many stands where it is now lacking.

BRIEFER ARTICLES AND NOTES

Forest Fire Fighters Memorial

A fire fighters' memorial, erected in honor of fifteen men who lost their lives in the Blackwater fire on the Shoshone National Forest, Wyo., was dedicated August 20, the second anniversary of the fire. The memorial is located at the junction of Blackwater Creek and the north fork of the Shoshone River. It is adjacent to the Cody-Yellowstone Road, thirty-six miles west of Cody.

The monument was constructed by the Civilian Conservation Corps. It is a massive stone structure, with an overall length of seventy-one feet. Steps lead up to the monument proper, which is forty-three feet in length and rises slightly over six feet above the ground line. The monument is of natural stone, trimmed to random pattern, and twelve feet in width. An inscription on terra cotta, set in to one course of stone which runs practically the full length of the monument, gives the names of all who lost their lives. At either end of the terra cotta are bronze seals of the Forest Service, U. S. Department of Agriculture, and the Civilian Conservation Corps.

On the rear of the monument is a bronze plaque on which is inscribed the following description of the fire:

Shoshone National Forest

blackwater fire, august 20-24, 1937

This marks the beginning of the Fire Fighters' Memorial Trail which follows Blackwater Creek five miles to the place of origin of the fire, and thence to other points of interest. This fire was controlled after burning over 1,254 acres of forest. Fifteen fire fighters lost their lives and thirty-nine others were injured when the fire was whipped up by a sudden gale on August 21. Signs and monuments mark the important locations along this trail, including the fire camps, the first aid station, Clayton Gulch, where eight men were killed, and the rocky knoll, where Ranger Post gathered his crew to escape the fire.

The dedication was sponsored jointly by the U. S. Forest Service and the American Legion.

Controlled Burning at $40 Per Acre; Is It Socially Justifiable?

In their excellent and informative discussion of controlled burning as a regenerative technique in the western white pine area, Davis and Klehm[1] estimate that unproductive land can be cleared and planted at an average cost of about $40 per acre. While arguing that there may be justification for such an expenditure, the authors state: "This is, of course, an essentially social viewpoint that under existing circumstances, the private individual cannot afford to share." The purpose of this note is to question the economic implications of that statement. No criticism is intended of the authors' research; the quoted sentence is merely a convenient spring-board into a brief discussion of a matter of social policy regarding which many persons, including some foresters, have not acquired a clear understanding.

It is accepted that this regenerative technique (controlled burning—which here is also simply a convenient illustration) is entirely feasible and effective from the silvicultural standpoint. The only point at issue is the economic one; therefore, in order to isolate and simplify this economic issue, all intangible values and secondary factors will be arbitrarily excluded from consideration. Also the computations that follow are over-simplified in the interest of brevity.

If the proposed expenditure for forest regeneration is economically sound, it must hold reasonable promise of yielding gross returns that are at least equal to all costs of the enterprise, including the current risk-free rate of interest on the aggregate capital investment. If the property were in private ownership, necessary costs per acre might be estimated as follows, assuming a 100-year rotation and no-value land:

[1]Davis, K. P., and K. A. Klehm. Controlled burning in the western white pine type. Jour. Forestry 37: 399-407. 1939.

Principal sum of $40 and interest at 3 percent compounded annually for 100 years	$768.74
Annual costs of 12c (fire protection 5c, management 2c, taxes 5c) accumulated and compounded at 3 percent for 100 years	72.87
Total investment at end of 100 years	$841.61

It is obvious that the above is an exceedingly conservative estimate of probable costs. An interest rate of 3 percent is too low to cover any allowance for risk, and no other provision is made for risk or possible losses. Also no provision is made for the cost of blister rust control. Management costs would probably exceed the figures mentioned above, and taxes would mount progressively as the value of the stand increased, if imposed in the form of the orthodox ad valorem levy.

At the end of 100 years, it is a fair assumption that the property might bear a stand of merchantable timber in the amount of 50 M board feet per acre, having a value on the stump of $8 per M. If a policy of complete liquidation were to be adopted at that time, the total return would be $400, leaving a net loss of $441.61 for the 100-year financial cycle.

If, as an alternative policy, all the above costs are regarded as capital investments, in the sense that they are incurred in order to restore the land to a condition of permanent productivity, the financial picture, highly simplified, would be something like the following: At the end of 100 years, granting that silvicultural considerations are not deterrents to the adoption of such procedure, one-half of the stand volume might be removed. This should be a selective cut of the highest grade stems, which might have a value of $11 per M. If so, the stumpage return would be $275, leaving an accumulated capital investment of $566.61. If the investment is economically sound it must thereafter yield an annual return not less than the current rate of interest, which is assumed to be 3 percent. As a generous estimate, suppose that the growth is 700 board feet per year and that this volume can be harvested annually. This affords a return of $5.60 per year, or approximately 1 percent on the accumulated capital investment. Obviously, no private individual, motivated by normal economic considerations, would knowingly and willingly make an investment offering such a small rate of return.

If this investment is economically unsound from the standpoint of the private investor, it is perforce equally unsound, economically, as a governmental investment. All the costs mentioned above would be chargeable to the property if it were governmentally owned. This is true even of ad valorem taxes, because when the property is removed from the local tax roll, either (1) the central government must make a monetary contribution to the local government approximately equal to the taxes that would have been paid on the property if privately owned, or (2) other sources of local revenue must be tapped more heavily to cover the local budget deficiency, or (3) the central government must contribute services or "payments-in-kind" that will serve in lieu of expenditures by the local government. In other words, the tax item is a "true" economic cost, and allowance must be made for it in overall social accounting if governmental investments are to be made in conformity with rational economic calculations, and if the charge is to be avoided that the government is in "unfair competition" with private enterprise.

It is apparent that the interest charge is a major factor in the above computations. Some persons have attempted to argue that forestry is not subject to the incidence of compound interest, but this position is patently untenable. Forestry is not a self-contained entity that exists apart from the rest of the economic universe, and no amount of mental gymnastics or "doing an ostrich" can isolate and insulate it from the operation of normal economic law.

An interest charge is inescapable in connection with every investment, and the only question involved is that of the applicable rate. "But the instant any investment whatever is made, it must be assumed to begin to yield a return which, since it is not instantly consumed, must be added to the investment itself."[2] Any investment of capital in forestry is on a par with any other investment of equal magnitude, subject to the same calculations and limitations. "That is, compound interest applies to every expense incurred for forest reproduction, forest protection, and every other expenditure made with a view to future income. This is true regardless of the source of the funds and regardless of whether the expenditures are made to establish a forest on denuded land or to continue an already organized forest."[3]

If the forestry enterprise is on an annual re-

[2] Knight, F. H., The quantity of capital and the rate of interest. Jour. Political Econ. 44: 433-463. 1936.

[3] Staebner, R. C., The problem of interest in forestry. Jour. Forestry 29: 763-767. 1931.

turn basis, the easiest accounting technique is to treat interest as a current operating expense, and as such it is not subject to compounding. If financial returns are intermittent, however, interest must be compounded for the entire period of income deferment. Nevertheless, there is need to emphasize that, in case of the annual sustained yield forest the products of which are sold at prices just equal to their true economic costs of production, identical results are obtained either by (1) figuring simple interest on the total current value of the forest, or (2) calculating compound interest to the moment of harvesting on trees of each separate age class, or even on each tree individually. In other words, there is nothing in the concept of compound interest that is not logically inherent in the concept of simple interest. The latter, thought of as a rate per annum, is merely an arbitrary break, on the basis of a convenient time interval, in a continuous process of accumulating and compounding infinitesimal accretions.

The significance and implication of this are no whit less applicable to governmental than to private investment. The investing governmental unit must itself carry the interest charge in one form or another; if the $40 investment becomes a part of the public debt, interest must be paid regularly thereon so long as the obligation remains outstanding; on the other hand, if the $40 is obtained from the sale of mature timber, it could be used to retire governmental indebtedness of that amount on which interest would otherwise be payable.

It is possible, of course, that the intangible and unpriced social values (watershed protection, game cover, and recreation) that inhere in reforestation under such circumstances may be great enough to offset the financial loss attendant thereon. Any excursion into the field of social incommensurables is beyond the concern of this note. It may be observed in passing, however, that every decision involving governmental investment policy should be made in the light of the most accurate and complete balance sheet of social costs and returns that can possibly be computed for each individual project.

It is stated in the Hale Report (and the same thought is elaborated in the Copeland Report) that "the play of economic forces will lead to the practice of intensive forestry on the most favorable situations before anything more than fire protection would be economically justifiable upon the poorer and more remote lands."[4] The wisdom of this policy is scarcely open to question. It follows, therefore, that whether this $40 comes from the federal treasury or from the pocket of a private investor, it probably could be used much more productively in protecting and improving several acres of well located land now bearing promising young growth, rather than effecting immediate restoration of one acre of comparatively inaccessible land. Only limited funds are available for the conservation and rehabilitation of the nation's forest resources, and social interests will be served best if those funds are allocated to the forestry investment margins that hold promise of the highest rate of return per dollar of investment. Any contrary policy can but add fuel to the fire of criticism of governmental economic planning.

Richard W. Nelson,
U. S. Forest Service.

A Unique Forestry Cooperative Organization

A high state of democracy is reached when men voluntarily pledge themselves to act for the common good. Such action has recently been exemplified by the organization of the Tioga Woodland Owners' Cooperative, Inc., the first private, nonsubsidized cooperative in the United States prepared to market exclusively farm forestry products.

During the early part of the year 1936, Prof. J. A. Cope, New York State extension forester, began searching for a suitable forest area that possessed the combined advantages of a large acreage of farm woodland, many improved roads, and an adequate number of wood-using industries. A tract of approximately 100,000 acres was finally selected in the southwestern part of Tioga County, N. Y.

True to the spirit of a cooperative enterprise, many agencies combined their efforts to make a complete inventory of the character of the woodland on each farm. The Soil Conservation Service furnished one forester, 25 C.C.C. enrollees, and necessary transportation. Tree growth studies were completed under the supervision of the staff of the Northeastern Forest Experiment Station. Region 7 of the U. S. Forest Service, Divi-

[4]Curran, C. E., and C. Edward Behre. National pulp and paper requirements in relation to forest conservation. Senate Document No. 115, 74th Congress, p. 47. 1935.

sion of State and Private Forestry, supplied C. R. Farrington to act as Project Chief. Finally, the New York State College of Forestry at Syracuse cooperated by assigning James E. Phillips to the job of investigating the silvicultural considerations involved in managing the farm woodlands.

The one hundred percent inventory called for the measuring and tallying of all hardwoods (except aspen) ten inches in diameter and above. Every pine and hemlock tree eight inches and over on woodlands larger than five acres was tallied. With a possible use of aspen for pulpwood, this species was recorded down to a diameter as small as six inches. Trees of smaller sizes were sampled less intensively. Property lines between farms were painted and a detailed map, showing the location of the houses, roads, fences, streams, and woods, was made.

This field inventory required about a year. In another six months, the necessary drafting, tree ring counts, and volume computations were completed.

Although the cooperative project so far required patience, technical skill, and hard physical labor, in reality the biggest job lay ahead—that of helping the woodland owners to organize so that the cooperative will gain momentum from its own merits.

County Agent A. R. Blanchard, together with Extension Forester J. A. Cope and Project Chief C. R. Farrington, called a series of farmers' meetings during the first week in August 1938, for the purpose of discussing such items as a satisfactory marketing agreement, property lines on the farm maps, and the purposes and ultimate aims of a forestry cooperative organization.

In the farmers' minds the idea grew slowly. Had they not been regimented, or tempted into regimentation, by other agencies recently? Did this cooperative movement not have the same ultimate purpose?

Finally, after an intentionally slow and painstaking start, the Tioga Woodland Owners' Cooperative Association, Inc., was granted legal recognition under Article 4 of the Cooperative Corporations Law of the State of New York.

The primary object of the organization as set forth in Article I, Section 2, of the By-Laws, is to ". . . improve the yield of farm woodlands and the income derived from these woodlands and at the same time establish a conservative cutting policy in the interest of a perpetual crop." This is apparently a two-fold conflicting purpose; for how can sustained yield and a greater income be combined? Later we shall see how this is possible.

Membership in this nonstock cooperative association is open to any woodland owner or tenant who makes application, agrees to abide by the by-laws, signs the marketing agreement, and pays a fee of one dollar.

Officers of the association consist of seven members, duly elected at the annual meeting. At the first meeting, three directors were elected for a term of one year; two for a period of two years; and two were given a three-year term of office. Each year hereafter, new directors will be elected for terms of three years. Thus, after this initial period of organization, a majority of the seven directors will be experienced in the business of the association.

Upon signing the marketing agreement, the woodland owner agrees:

1. To have his trees marked before cutting and his logs scaled by a competent man chosen by the association.

2. To market his woodland products through the association. (Trees cut for home use are exempt from this agreement.)

3. To pay the necessary costs involved in marking, scaling, and bookkeeping.

In return, the association agrees in part:

1. To train and make available for the members a qualified timber marker and scaler.

2. To act as lawful agent in securing the best possible price for the products sold.

3. To mingle forest products from different members if it is in the best interest of the association as a matter of economy or expediency.

So far, the woodland owner has paid a dollar to become a member of the cooperative association and has signed a binding agreement to market his forest products through the association. How can the objectives of a greater income and a perpetual tree crop be combined in harmony to benefit a member of the association?

First, let us analyze the cutting, logging, and selling practices that the average nonmember woodland owner uses. He leaves high stumps, measures the log lengths with his axe handle, cuts some logs with top diameters as small as six inches, and is not concerned about what percentage of his log volume is made up of fourteen and sixteen-foot logs. After cutting the logs, he then seeks a buyer who estimates the number of board

feet by the Doyle rule—a rule which favors the buyer. An alternative method of selling timber is for the buyer to display conspicuously a roll of new bills and to make the owner a flat offer for all of the timber on his farm. The buyer then proceeds to cut every tree that will make a two by four. Both methods result in low income by the owner as well as "butchered" woodlands.

On the other hand, if a member of the association wants to sell some sawlogs he requests the trained timber marker to paint a spot on each tree that is of the proper size and species and whose removal will leave the forest in the best possible condition for future growth. The member uses extreme care in felling the trees so as not to injure unduly the future crops. He leaves low stumps, measures each log with a tape so as to have exactly a three-inch trimming allowance, cuts no longs with less than a ten-inch top diameter, and is careful to include in the lot the specified number of fourteen and sixteen-foot logs to bring top prices at the Cotton and Hanlon mill. The member again asks for the services of the association's log scaler who estimates the number of board feet in each log with the use of the Scribner rule which gives about fifteen percent more volume than the Doyle rule.

To make membership in the association still more attractive. the Cotton and Hanlon mill at Cayuta has agreed, in the interest of a perpetual crop, to pay bonus prices exclusively to members of the cooperative.

Thus, we have an agreement between producer and buyer, set in motion by astute foresters, that is capable of accomplishing the dual purpose of a greater woodland income as well as establishing a conservative cutting policy with the aim of a perpetual tree crop.

Roy L. Donahue,
Cornell University.

A New Growth Curve and Its Application to Timber-Yield Studies

The Pearl-Reed population growth curve has been applied by MacKinney *et al* to the volume yield (in cubic feet of entire tree stem) of loblolly pine with very satisfactory results.[1] The chief difficulty in its application is that prior knowledge is required concerning the maximum yield towards which stands of given site quality and density of stocking approach just before they begin to break up. This is a serious drawback to the use of the curve, at least in the Southeast where stands are seldom left intact to advanced age.

It is the aim of the present note to develop a simple growth curve type applicable to timber-yield of the entire stand.

The volume-yield curve of an even-aged timber stand has certain characteristics in common with other growth curves. Among these—quoting from MacKinney *et al*[1] (p. 534)—are the following:

1. The curve is limited between zero yield at inception and a finite maximum yield at that advanced age just before the stand commences to break up. Thereafter the stand loses its even-aged character. Volume loss due to mortality exceeds the periodic growth of all the survivors, and openings are normally taken over by a new generation.
2. The curve exhibits a declining rate of percentage increase; or, in forest mensuration terms, growth percent varies inversely with age.
3. The slope of the curve increases with increasing yield in early life and decreases with increasing yield in later life. The current annual growth curve rises rapidly as long as the trees have ample room for good growth, but declines during the intense struggle for light and space because the stand loses continually the volume of the less vigorous trees, which are first suppressed and then supplanted by the dominant individuals. Current annual increment becomes zero as the maximum yield is attained.

While these characteristics led, in the case cited, to the Pearl-Reed curve, an alternative—and simpler—conception of growth is contained in them. Let us suppose that the second characteristic be taken literally; that is, that growth percent varies inversely with age. Expressing this concept as a differential equation, we have, when denoting volume by V,

$$\frac{dV}{V} = k.d\left(\frac{1}{A}\right)$$

where A signifies age, and k is a constant peculiar to the site index and density of stocking in question. Upon integrating and changing the base from Naperian to common logarithms, we have

$$log\ V = a+b\left(\frac{1}{A}\right) \qquad (1).$$

in which b is $0.4343k$, and a is the logarithm of the maximum volume towards which the stand approaches. It is also, therefore, peculiar to the site index and density of stocking in question.

[1]MacKinney, A. L., F. X. Schumacher, and L. F. Chaiken. Construction of yield tables for nonnormal loblolly pine stands. Jour. Agric. Research 54:531-545. 1937.

As a first approximation we may take a and b of equation (1) to be linear functions of these variables. Denoting site index by S, and density of stocking by D, we have, accordingly,

$$\left.\begin{aligned} a &= a_0+a_1S+a_2D \\ b &= b_0+b_1S+b_2D \end{aligned}\right\} \quad (2).$$

Should the yield investigation be concerned with "normal" stands only, D is itself a constant and equations (2) are not concerned with it. Under this condition

$$\left.\begin{aligned} a &= a_0+a_1S \\ b &= b_0+b_1S \end{aligned}\right\} \quad (2a).$$

Upon substituting equations (2a) into (1) we have the form of the growth curve for "normal" stands, and equation (1) becomes

$$\log V = a_0+a_1S+(b_0+b_1S)\frac{1}{A}$$

or

$$\log V = a_0+b_0\left(\frac{1}{A}\right)+a_1(S)+b_1\left(\frac{S}{A}\right) \quad (3).$$

Form (3) is immediately recognized as a linear equation in the transformed variables; hence the constants a_0, a_1, b_0, *and* b_1 may be calculated by the method of least squares from a set of observation equations. The dependent variable is the logarithm of volume to the unit area; and the independent variables are, in turn, the reciprocal of age $\frac{1}{A}$, site index S, and the ratio of site index to age $\frac{S}{A}$.

The yield equation (3) is in harmony with the growth characteristics cited above. The curve starts with zero volume at zero age, carries an inflection, and aproaches maximum volume as a limit, the logarithm of the latter volume being

$$a_0+a_1S$$

of equation (3). The inflection of the curve is at the age

$$A = -1.1513(b_0+b_1S),$$

which is also, by definition, the age at which the current annual growth curve culminates. As is to be observed it varies with site index.

Mean annual growth is maximum at the age

$$A = -2.3026(b_0+b_1S)$$

and this also varies with site index.

This growth curve has been applied successfully in yield investigations to loblolly pine and to Virginia pine at the Appalachian Forest Experiment Station. As an exercise in curve fitting in the course in forest mensuration at Duke University, it has been applied to the longleaf pine data of the first three columns of Table 36 of *Forest Mensuration*,[2] with the following results:

$$\log V = 0.6381-32.9137\frac{1}{A}+0.004284(S) + 0.2406\frac{S}{A}.$$

For selected site indexes of 50, 70, and 90 feet at 50 years, this simplifies to a separate equation for each.

Site index 50: $\log V = 0.8521-20.8837\ \frac{1}{A}$

Site index 70: $\log V = 0.9377-16.0717\ \frac{1}{A}$

Site index 90: $\log V = 1.0233-11.2597\ \frac{1}{A}$

The age of maximum current annual growth according to each of these site indexes is, respectively, 24.1, 18.5, and 12.8 years; while the culmination of mean annual growth is at 48.2, 37.0, and 25.7 years, respectively.

F. X. Schumacher,
Duke University.

Forest Seed Policy of U. S. Department of Agriculture

Recognizing that trees and shrubs, in common with other food and fiber plants, vary in branch habit, rate of growth, strength and stiffness of wood, resistance to cold, drought, insect attack, and disease, and in other attributes which influence their usefulness and local adaptation for forest, shelterbelt, and erosion-control use, and that such differences are largely of a genetic nature, it shall be the policy of the U. S. Department of Agriculture in so far as practicable to require for all forest, shelterbelt, and erosion-control plantings, stocks propagated from segregated strains or individual clones of proven superiority for the particular locality or objective concerned. Furthermore, since the above attributes are associated in part with the climate and to some extent

[2]Bruce, D., and F. X. Schumacher. Forest mensuration. 354 pp. Illus. McGraw-Hill Book Co., New York. 1935.

with other factors of environment of the locality of origin, it shall be the policy of the U. S. Department of Agriculture:

1. To use only seed of known locality of origin and nursery stock grown from such seed.

2. To require from the vendor adequate evidence verifying place and year of origin for all lots of seed or nursery stock purchased, such as bills of lading, receipts for payments to collectors, or other evidence indicating that the seed or stock offered is of the source represented. When purchases are made from farmers or other collectors known to operate only locally, a statement capable of verification will be required as needed for proof of origin.

3. To require an accurate record of the origin of all lots of seed and nursery stock used in forest, shelterbelt, and erosion-control planting, such records to include the following minimum standard requirements to be furnished with each shipment:

(1) Lot number.
(2) Year of seed crop.
(3) Species.
(4) Seed origin:
State
County
Locality
Range of elevation
(5) Proof of origin.

4. To use local seed from natural stands whenever available unless it has been demonstrated that seed from another specific source produces desirable plants for the locality and uses involved. Local seed means seed from an area subject to similar climatic influences and may usually be considered as that collected within 100 miles of the planting site and differing from it in elevation by less than 1,000 feet.

5. When local seed is not available, to use seed from a region having as nearly as possible the same length of growing season, the same mean temperature of the growing season, the same frequencies of summer droughts, with other similar environment so far as possible, and the same latitude.

6. To continue experimentation with indigenous and exotic species, races, and clones to determine their possible usefulness, and to delimit as early as practicable climatic zones within which seed or planting stock of species and their strains may be safely used for forest, shelterbelt, and erosion control.

7. To urge that states, counties, cities, corporations, other organizations, and individuals producing and planting trees for forest, shelterbelt, and erosion-control purposes, the expense of which is borne wholly or in part by the federal government, adhere to the policy herein outlined.

M. A. McCall,
Chairman, Seed Policy Committee.

Approved:

F. A. Silcox,
Chief, Forest Service.

May 29, 1939.

D. S. Myer,
Acting Chief, Soil Conservation Service.

June 8, 1939.

H. A. Wallace,
Secretary.

June 21, 1939.

Hardware Cloth Seed-Spot Screens Reduce High Surface Soil Temperatures

Screens made of hardware cloth are commonly used to protect seed-spots in forest plantations from the depredations of birds and rodents. It is important to know whether or not the screens influence germination and survival of seedlings in addition to furnishing protection against animals.

At the Stanislaus Branch of the California Forest and Range Experiment Station, near-surface soil temperatures were measured under a 4-mesh, 20-gauge hardware cloth screen made in the form of a cone 10 inches high and 10 inches across the base. The base of the screen was set about one-half inch into the soil during the described observations. (In plantations the screens usually are pressed into the soil about 2 inches.) The location was on a southerly aspect at 5,200 feet altitude, was cleared of vegetation, and was not covered by litter. Two mercurial thermometers, gooseneck type, were placed inside the cone and two more were placed just outside, unshaded by the cone. The bulbs were covered with one-quarter inch of soil.

The 1938 daily averages of the two maximum temperatures inside the cone and outside the cone were treated as a series of paired observations and analyzed by the familiar t test. The following figures summarize the data:

Average maximum temperature outside cone 134.3°F.
Average maximum temperature inside cone 122.1°F.

Mean difference	12.2°F.
Standard error of mean difference	0.326
t	37.4
Degrees of freedom	68

Since the value of *t* at the one percent level, with 68 degrees of freedom, is approximately 2.65, the differences between the temperatures inside and outside the cone are obviously very significant. Krauch,[1] studying regeneration, has suggested that screen cones not only protect seedspots from rodents but also produce a favorable shade. It is conceivable that the use of cones also might reduce the mortality of seedlings caused by high surface soil temperatures.

H. A. Fowells and R. K. Arnold,
California Forest and Range Experiment Station.

Watershed Management is More Than Production of Water

Connaughton's article in the April Journal of Forestry is appropriate and timely. He is right in saying that watershed management is generally only a term in the vocabulary of foresters. However, he has overlooked the fact that in humid sections of our country flood control may be of great importance in watershed management. Perhaps his definition might read: Watershed management is the practice of handling the resources of a drainage basin for the proper control of water.

It is necessary that foresters responsible for land management accept the full measure of their responsibilities for watershed management, but it must be remembered that the cooperation of meteorologists, engineers, and agriculturists is needed in many cases to do a competent job. In upstream engineering foresters, engineers, and agriculturists all have definite parts and all are needed.

At present the great need of watershed management is research. Much work is needed on the interactions between water, vegetation, and soils before the most efficient watershed management practices can be developed. The field of hydrology belongs to no one profession. Water has a thousand contacts with other substances in its course from water vapor in the atmosphere to streams in the bowels of the earth. The efforts of meteorologists, biologists, geologists, soil scientists, engineers, agriculturists, and foresters will be needed before all the fundamental principles are determined. Then it may be still longer before these principles are used in formulating efficient methods of watershed management for all conditions to be effectuated by foresters, agriculturists, and engineers. However, in the meantime foresters should utilize all available data and take an active and aggressive part in watershed management.

Clarence Hill Burrage,
Tennessee Valley Authority.

Comments on "Why Forest Plantations Fail"

Acting upon the suggestion that discussions of articles appearing in the Journal of Forestry are welcome, the writer wishes to comment on "Why Forest Plantations Fail," published in the May issue. Because the writer has spent 11 years in Michigan, most of which were devoted to promoting reforestation, he has more than ordinary interest in this article.

The writer seriously questions the sufficiency of the evidence presented in the article to warrant some of the conclusions, particularly those pertaining to the slit method of planting.

In the first place, the author states that the purpose of the study was to learn (1) the effect of root placement and development on mortality, (2) the effects of cover on mortality, and (3) the effects of certain soil factors. Inasmuch as the soil factors were constant, the study really involved only items (1) and (2).

The author states, "The study has shown rather conclusively that young red and jack pine trees which have their root systems predominantly cramped into a single plane suffer a significant decrease both in survival and height growth as compared to those trees which have more uniform root development. This fact seems to be somewhat of an indictment of the slit method of planting. . . . ." It may be inferred from the above quotation that the author refers to trees killed by drought, as he advocates planting trees

[1]Krauch, H. Does screening of seed-spots do more than protect the spots against rodents and birds? Southwestern Forest and Range Exp. Sta. Research Note 49. 1938.

in the protection of other growth for better survival from death due to heat. This leaves only 20 percent to 50 percent mortality due to drought and it is very questionable whether this mortality should be charged to the method of planting in a year such as 1936. We are, after all, not so much interested in percentage survival as in enough survival to establish cover. Foresters plant 1,000 to 1,700 trees per acre to allow for some loss.

A consideration of the data presented shows that a very important factor, namely depth of root system, evidently was left out of consideration as a possible factor in mortality. At least the author makes no mention of this. The data show that the dead trees had a shallower root system than the live trees. In a severe drought year this is probably a much more important factor than the proportion of roots at right angles to the slit, as it is a matter of general knowledge that moisture in the soil varies according to depth. Let us examine the following significant facts. The 2-year live jack pine had an average depth of root of 8.4 inches. The dead *3-year* jack pine only had a root depth of 7.6 inches. The roots in the slit and lateral spread of the 3-year dead jack pine, however, exceeded that of the live 2-year jack pine.

A somewhat similar relationship is observed in the case of the red pine, even though the dead 10-13 year old trees had slightly greater depth of roots than those 3-6 years old. The data show that the live 3-6 year pine had an average root depth of 11.5 inches and the dead 10-13 year pine a depth of 12.8 inches. In other words, the dead trees which were 7 years older than the live ones had an average greater depth of roots of only 1.3 inches. These facts, brought out particularly by the jack pine, would lead one to conclude that depth of roots was equally if not a more critical factor than roots at right angles to the slit.

If the data prove anything, it is that those trees with the best developed and largest amount of root system withstood drought the best.

As a substitute for slit planting, the hole method or wedge method is suggested. Without going into details of all the disadvantages of hole planting, the most important, that of cost, will be considered briefly. The writer kept records for three years on 7 different jobs in the States of Ohio, Indiana, and Illinois. Hole planting averaged 235 to 311 trees per man-day, or a cost of \$13.77 to \$25.58 per acre. On the same areas slit planting averaged 434 to 837 trees per man-day, with a per acre cost of \$6.10 to \$10.80. In other words, with a 100 percent failure, a replacement could be made at a total cost of less than that involved by the hole method. Furthermore, will any forester maintain, to begin with, that costs of \$13.77 to \$25.58 per acre are justified in large scale planting?

It was unfortunate that the study was made during a most unfavorable year and on the poorest soil type that foresters are likely ever to encounter. As Lovejoy so aptly puts it, "The oldest national forest in Michigan, meanwhile, has continued to plant pine in delta sugar sand so poor that the original forest was hardly worth stealing."[1]

More forest planting studies are needed and will be welcomed by all foresters. These should, however, start from "scratch" and cover a range of factors such as soil types, age of stock, costs, furrows, scalps, etc. The weakness of the study under discussion lies, as the author intimates, in the fact that there were no check plots put in by the hole method. It is difficult to see, therefore, how any concrete conclusions can be drawn. The writer offers as evidence that slit planting has proved entirely satisfactory, the fact that there is very good survival today on hundreds of plantations in Michigan put in prior to 1936. Most of these were planted under "sand plains" conditions.

R. F. Kroodsma,
Milwaukee, Wis.

A Correction

Hermann Krauch wishes to correct an error made in his review of *Factors Affecting the Establishment of Douglas Fir Seedlings* by Leo A. Isaac in the August 1939 issue of the Journal.

Line 8, page 668 read, "Maximum surface temperatures were found to be considerably higher in shade." It should have read, "Maximum surface temperatures were found to be considerably higher in the open than in the shade."

[1]Lovejoy, P. S. Concepts and contours in land utilization. Jour. Forestry 31:381-391. 1933.

REVIEWS

An Outline of Forestry. By Thomas Thomson and M. R. K. Jerram. *vii+208 pp. 4 pl., 11 fig. Thomas Murby & Co., London, and Nordemann Publishing Co., Inc., New York. $2.25.*

The outstanding quality of this book is its presentation of a clear-cut, unified picture of forestry. The authors start out with a discussion of forest policy by contrasting the policy of a nation with that of a private owner; they then show the division of the field into forest bionomics, which includes silviculture and protection, and forest economics, in which they place finance, mensuration and utilization; these are tied together into forest management, culminating in a discussion of the regulation of the yield and the preparation of forest working plans. Thus the authors present the whole field of forestry in one neat little bundle.

In these days when Joint Congressional Committee hearings provide sounding boards for many conflicting ideas of forest policy, it is refreshing to find an *objective* presentation of national forest policy, including the advantages and disadvantages of state and private ownership. The authors base their presentation on the experience of the Forestry Commission of Great Britain in trying to promote private forestry. For this reason the following quotation will be of interest to those in this country who maintain that their panacea of greater expenditures by the federal government for fire protection, research, and grants-in-aid without any *quid pro quo* will result miraculously in universal sustained yield:

"The assumption made [by the Forestry Commissioners] that private owners, with such encouragement as could be given them, would restore their devastated woodlands and maintain the pre-war areas of forest in production, has not been fulfilled. It looks as if the state will have to undertake an even greater share of the task of building up a stock of growing timber in the country, than was anticipated."

Another quotation which will strike a responsive chord in many quarters, is:

"The Forest Authority should have at its disposal a revenue which it can count upon for a period of years, so that its plans may be made in advance and its work proceed in an orderly manner."

It is earnestly recommended that all those involved in the present attempt to formulate an intelligent forest policy through the Joint Congressional Committee read at least the first chapter of Forest Policy.

The very readable presentation of silviculture, protection, and the various phases of forest economics proves that subject matter, which some American writers insist on making involved and complicated, can be expressed in rather understandable language. This subject matter does not differ materially in scope and content from our American forestry texts.

The discussion of the regulation of the yield and forest working plans is brief, but nevertheless the authors adequately outline the essential factors. The eight pages of glossary are decidedly helpful.

On the adverse side, if there must be one, it should be pointed out that the authors have not quite attained their objective in trying to "dispel the ignorance" of those whom they call laymen. In other words, the technical terms which have crept in, unavoidably of course, interfere with the semi-popular style which would appear to be necessary to reach the layman. (Of course, the British layman may be at a somewhat different level than his American prototype). The authors do not claim that this book should be considered as a text on forestry, and so this places it somewhere between a popular treatise on forestry and a very readable handbook. It does not, however, compare favorably as a textbook with the more comprehensive *An Introduction to American Forestry* by Shirley W. Allen.

It should nevertheless be read by all American foresters, especially those whose duty it is to explain the meaning of forestry to the general public, agricultural students, private forest landowners, congressmen, and other "laymen."

M. A. Huberman,
U. S. Forest Service.

Kahlschlaglose Wirtschaft im Kiefernrevier. (Management of the Pine Forest without Clear-Cutting). By H. Weck. *Mitteilungen aus Forstwirtschaft und Forstwissenschaft. 9: 242-252. 1938.*

In 1922 Alfred Möller described the *Dauerwald*, or continuous forest, and stated that Dauerwald is not to be interpreted as a silvicultural system but that it is a general, comprehensive principle for the forester to observe. Möller argued that any method of silviculture which does not serve to bring the forest to its highest productivity, or which upsets the balance attained in the interrelation of site factors by attempting to "force sudden and drastic changes upon the forest," is contrary to natural law and is to be avoided. As Dr. Weck remarks, the changes in a Dauerwald forest are most gradual. Under such intensive management, he states, it is impossible definitely to mark the time when thinnings end and reproduction cuttings begin.

Möller's ideas have stood as the antithesis of the traditional clear-cutting method so long practiced in Germany. But when the theoretical principles of Dauerwald, which include such general conditions as balance between site and stand, productivity of the soil, mixed and uneven-aged stands, and a sufficient and uniformly distributed quantity of merchantable timber of at least cordwood size were more closely scrutinized, their impracticability of application in individual cases was realized. To bridge theory and practice every other forester upheld a different silvicultural method as being synonymous with Dauerwald. Some, as the late Wiebecke of Eberswalde, thought of the Dauerwald forest as a selection forest. Others considered it to be group shelterwood. At last some point of compromise has been found in that a state decree defines Dauerwald as a principle that can find application in all silvicultural systems except clear-cutting. The use of clear-cutting is to be a "most rare exception." To this extent, then, have Möller's ideas been incorporated into German forestry.

In this article Weck discusses his forest of Eberswalde in Prussia as a definite example of a shift away from clear-cutting. The change is of particular significance because Eberswalde is in the north German sand plain where clear-cutting of Scotch pine has been the traditional practice. Pine is accompanied by a small proportion of hardwoods as beech and oak. Whereas Alfred Dengler, eminent professor and silviculturist of the Eberswalde Forestry College, holds that, even on good sites, these mixed stands should be clear-cut and then followed by pure Scotch pine, Weck, believing in a mixed stand, is prepared to use a group shelterwood method with artificial reproduction. Groups are begun wherever the cover of the old stand thins, and are widened toward logging trails. After the pine has been established for 40 or 50 years hardwoods may be introduced. A mixed stand results in which high-quality pine will be produced under the influence of the half shade.

Dr. Weck believes that under his system not only the quality but also the quantity of timber produced will be improved. However, he realizes that it is difficult to prove that the quantity of timber produced under his method of cutting will be greater or less than if the intermediate cuttings were heavier or lighter. He does presume that the points of lowest productivity lie at the extremes of clear-cutting on one hand, and no intermediate cutting on the other, and that the optimum amount to be cut is to be found somewhere between these opposites. Within this range it is not the intensity of thinnings and cuttings, but rather the choice of stems left to grow that is the crucial factor.

To Dr. Weck's knowledge none of the best-quality pine of the Prussian markets has been grown on areas that were clear-cut. He suggests that complete cultivation of the soil prior to regeneration, in conjunction with pruning and intensive care of the growing stock, will produce similar high-quality wood; nevertheless, the broadleaf admixture he considers essential is missing in such stands. He would prefer Scotch pine growing in shade with a long period of repression, resulting in a late culmination of maximum diameter growth. This maximum would in Eberswalde be at anywhere between 120 to 220 years, and, although no definite figure is given for the period in repression, it appears to be about 60 years.

There is no question that Weck's method fulfills all of Möller's requirements for the Dauerwald. The critical point in determining the success or failure of his management, however, is recognized to be the behavior of the pine under shading. To regulate the proper amount of light requires a most intensive forest management. Weck understands this and, in refusing to designate any one factor that should lead the forester to an abandonment of clear-cutting, features the economic limitations that hinder any

attempts at painstaking silviculture in forests with smaller, relatively less skilled staffs at their disposal than Eberswalde. Some of the East Prussian forests are too large and undermanned;[1] there, and in similar districts, Dauerwald is not merely a question of site conditions being favorable for the maintenance of advance reproduction, but of whether any method other than clear-cutting can be economically and successfully employed until the size of units is reduced.

The German interpretation of Dauerwald has, then, become broad enough to fit actual working conditions. American foresters will appreciate that the original formulation of the concept can have but purely theoretical application for conditions in most parts of this country; also, that we cannot pull the interpretation of Dauerwald beyond the point to which the Germans themselves have stretched it. Beyond this point it becomes absolutely meaningless.

Paul E. Bruns,
Yale School of Forestry.

La Rivista Forestale Italiana. (Italian Forestry Review.) Augusto Agostini, Founder and Director. *Vol. 1, No. 1, March 1939. 68 pp. Illus. Istituto Poligrafico dello Stato, Libreria dello Stato, Rome. Monthly. Foreign subscription, 50 lire.*

L'Alpe, the forestry magazine published for 25 years under the auspices of the Touring Club of Italy, suspended publication at the end of 1938. In its place comes a new and more elaborate journal, published under the direction of Prof. Dr. Agostini, commanding general of the National Forest Militia (Forest Service), with the collaboration of Drs. Merendi, Pavari, Sala, and Saladarelli, all of whom are also officers of the Forest Militia.

The new Review is well printed on good paper and is copiously illustrated with excellent photographs. Although it will have considerable popular appeal, its major purpose is to present the results of technical forestry work and to promote forestry throughout Italy and its possessions. This first issue contains an interesting account of the Italian Forest Survey and the resulting forest map of the Kingdom, which was completed in 1938. This map, a section of which is reproduced, shows in colors, on a scale of 1:100,000 and on a topographic base, the location of the forests by major types, species, and forest forms. Other articles include "Races of Forest Trees and Source of Seed," "Autarchy in Timber Production," "Cultural Care of Newly Planted Forests," and "Experiments in Afforestation of the Plateau of Western Friuli." There is also a section devoted to reviews, and one containing brief notes on forestry in Italy and other countries.

W. N. Sparhawk.

Mechanized Logging. By C. R. Townsend. *Illus. Woodlands Section, Canadian Pulp and Paper Association. 90 pp. 1938. $3.*

Except on the West Coast, where sheer size of the timber compelled the use of machinery, the logging industry has been slow to adopt mechanical methods in lieu of the muscle power of men and horses. The advent of the tractor and the rapid expansion of our road system which has permitted the truck to penetrate practically every forested area is bringing about a rapid change in logging methods everywhere. The practical logger is an inventive individual and as soon as he begins to use a standard machine, such as a truck or a tractor, he proceeds to overhaul it, add a gadget here, take one off there, and generally redesign it to fit his specific logging problem. Thus mechanization moves ahead on some fronts and lags behind on others, largely because there is no clearing-house for exchange of ideas among the logging fraternity and for passing on the good ones to the manufacturers of equipment.

In *Mechanized Logging* Townsend has brought together a tremendous amount of factual data on current methods of adapting standard machinery to logging problems in the United States and Canada. The report covers cable logging, tractor logging, truck logging, portable power saws, loading and unloading, road construction, camps, power and the operating costs and care of heavy equipment generally. Abundantly illustrated by clear photographs and excellent line drawings, the many rather complicated cases described are easy to follow and full of pertinent suggestions for adaptation of methods to new situations.

[1]Administrative units of 12,500 to 25,000 acres, with ranger districts of 2,500 acres! Weck has eight foresters and an office staff to help him manage the Eberswalde unit of 10,000 acres.

It is a book that ought to be on the desk of every logging superintendent, in the designing room of every logging equipment manufacturer, and in the library of every forestry school.

Admittedly a report on a current and rapidly changing situation, it deserves the support of wide distribution so that the author and his sponsors may be encouraged to follow it with others of a similar nature.

D. M. MATTHEWS,
University of Michigan.

Das Pflanzenleben der Ostalpen. (The Plant Life of the Eastern Alps.) By Rudolf Scharfetter. *xv+419 pp. Map, 73 figs. Franz Deuticke, Vienna and Leipzig. 1938. Pr. 24 RM (paper covers) and 25.80 RM (cloth).*

Thirty years of spare-time work, including hundreds of botanizing excursions and the perusal of "more than a thousand botanical writings," went into the preparation of this volume, which aims to present in one place all of the essential existing knowledge of the complex flora of the region. The author does not pretend to have said the last word on the subject—indeed, he says, "The Plant Life of the Eastern Alps cannot be written until sometime in the future. What I can offer in the following pages is only an attempt to bring together the building stones for this great work. Almost every chapter needs new investigations, new working over."

The Eastern Alps is defined as that portion of the Alps lying east of a line from the Bodensee (Lake of Constance) to Lake Como, and with the adjacent foothills and lowlands extends from the Danube on the north to the Po on the south, and east somewhat beyond a line running from Vienna to Trieste. It includes parts of Germany, former Austria, Yugoslavia, Italy, Liechtenstein, and Switzerland. This area is the meeting place of several distinct floras: the Mediterranean, the Illyrian, the Pannonian, the Baltic, and the Alpine. The result of the geographic situation, the geological history, and several thousand years of human interference is an exceedingly complex and varied series of plant associations and vegetative types. Dr. Scharfetter has done what appears to be an excellent job in organizing and synthesizing the vast amount of information on all of these types of vegetation, including that of the lakes and the moors, the meadows and pastures, the cultivated fields, the forests, and the high alpine areas.

Not only does he describe the floristic composition and ecological relationships of the various plant associations, but he also discusses the vegetational history of the region, from the uplifting of the Alps, through the glacial periods, and down to the present. Much information is given on the migration of plant species and forms in response to topographic and climatic changes and as a result of human migration since the Stone Age. Except for the higher Alps, most of the region was originally forest, and a large part of it remains forest to this day. Forest vegetation, the factors conditioning its distribution and composition, and the changes it has undergone in arriving at its present state consequently occupy a large share of the book.

Many, if not all, of the "more than a thousand botanical writings" upon which the author drew for information are listed in a 38-page bibliography. The value of the book as a reference work is enhanced by an index of upward of 2,400 plants mentioned in the text.

W. N. SPARHAWK.

Thinning, Pruning and Management Studies on the Main Exotic Conifers Grown in South Africa. By I. J. Craib. *Union South Africa Dept. Agric. and Forestry Science Bull. 196. 179 pp. 39 fig. Pretoria. 1939. Pr. 1 shilling.*

The revolutionary findings of Dr. Craib as applied to wattle culture[1] have in this bulletin been formulated into a practical system of applied technique for pine plantations, the objective of which is to treble the yield per acre of high-class products, and transform public forestry from a largely submarginal to a profitable enterprise.

South Africa has the advantage of possessing a natural habitat which, while practically devoid of native conifers, possesses climatic and edaphic factors extremely favorable to conifer growth. Of the exotic species so far planted on a large scale, *Pinus insignis* (Monterey pine) and *P. patula* (a Mexican pine) have shown average maximum yields at 30 years on first quality site

[1]The place of thinning in wattle silviculture and its bearing on the management of exotic conifers. Empire Forestry Jour. 13: 193-212. December 1934.

of 7,500 and 8,840 cubic feet per acre, respectively, or a mean annual growth of 391 and 406 cubic feet, with average d.b.h. of 17 and 18 inches and heights of 120 feet. It happens, however, that a large proportion of the plantations have been formed of *P. pinaster* (maritime pine), whose performance, on the same site, is much less satisfactory. Yields at 30 years are but 3,860 cubic feet, average d.b.h. only 11 inches, height only 70 feet, and mean annual growth only 127 cubic feet. *Pinus caribaea* and *P. taeda* are classed as "medium fast" growers and do somewhat better. Other exotics such as *P. canariensis*, *P. longifolia* and *P. palustris* are grouped with *P. pinaster* as "slow growing" and unsatisfactory from the standpoint of economic forestry. The present area of plantations is roughly classified as, Quality I, 20 percent, II, 50 percent and III, 30 percent. An area of 213,000 acres has been planted by the government to conifers, of which the two fast growers *P. insignis* and *P. patula* occupy but 25 percent, *P. caribaea* and *P. taeda* 15 percent, and the slow-growing species of the *P. pinaster* group 60 percent.

The afforestation program of the Union has been in full swing since the Great War, and is proceeding at the rate of 16,000 acres a year. It will be completed, that is, the 587,000 acres of publicly owned land suitable for planting will have been stocked, within 25 years, in proportion of 90 percent conifers and 10 percent hardwoods. This area will then be capable of yielding 70 million cubic feet annually, which is about one-half of the calculated requirements of the Union.

The problem of transition from an economy based almost entirely on imported wood to one founded on utilization of home-grown forests has presented many difficulties. "The expansion of this new industry has been hampered by the apathy of large and powerful wood-importing firms, by lack of knowledge, experience and capital on the part of private enterprise, by the reluctance with which the state has been prepared to undertake departmental saw-milling in competition with private enterprise, and, particularly, by the almost complete absence of personnel trained in the saw-milling business. . . . It is with marked reluctance that the Division of Forestry has gradually come to the conclusion that private enterprise will not develop at a rate great enough to cope with the conversion of rapidly increasing local coniferous wood supplies. . . . It is for this reason that the state has, during recent years, erected and operated sawmills at several centers. Two large state mills are already working up to capacity and the erection of two more has been sanctioned. . . . Despite the present trend, however, wholesale departmental milling is not likely to materialize. It is incumbent upon the state to bear the brunt of the utilization programme only so long as private enterprise is either unable or unwilling to undertake it. . . . It is the considered policy of the state that wood conversion and manufacture should gradually be handed over to private enterprise, with the exception of pilot mills."

By 1980, a total of 63 mills, each with an annual capacity of 700,000 cubic feet (approximately 5 million board feet) will be needed to handle the output of government timber. These will employ some 15,000 men and produce $15,000,000 worth of salable products annually.

If utilization does not develop at a rate to keep pace with silviculture, especially with the fellings demanded by silvicultural needs, it will require either thinning irrespective of utilization (which is not otherwise advised), state assistance to private enterprise, or the curtailment of the rate of afforestation.

The principal theme dealt with is the necessity for a radical revision of silvicultural methods in order to transform operations now submarginal into profitable workings. Without minimizing the indirect benefits of forests, the objective of this federal project is primarily economic. The methods proposed have been approved by the Forest Service of South Africa, which is translating them into action as far as circumstances will permit.

Unless trees—our American species—behave differently in South Africa than in their native habitat, American foresters may well study these adopted practices of our neighbor.

The factual basis upon which these silvicultural policies are formulated is of especial interest to students of forest mensuration and statistical methods. Yields are based on even-aged stands, with rotations of 30, 40, and 50 years for site qualities I, II, and III, respectively. Percentages of utilization for given top diameters are shown, and the quantities and relative values of four size-classes of product given, from which money yield tables can be deduced based on prices.

The conclusions emphasized by existing practice are the extreme differences in yields from inferior and superior sites, and from slow grow-

ing and fast growing species, and the still greater differences in values of small and large logs. The cost of production will probably exceed the revenue at finality on 80 percent of the area.

The problem thus presented has been attacked through revolutionary changes in thinning practices, in favor of drastic and early thinnings accompanied by pruning of live branches to obtain a minimum radius of 4 inches of clear lumber. "The technique of research on thinning has, during recent decades, become greatly complicated because of the demands for replication made by specialists in biometry. Their contention is, briefly, that differences due to treatment will never be known with precision until due allowance is made for differences due to soil variation. Unfortunately, the now generally accepted standards of replication in research technique have been based almost exclusively upon agricultural or other problems where results are obtainable in relatively short periods of time from relatively small units of area. In silvicultural thinning problems each individual tree is liable to have an effective root spread of 100 feet at maturity; rotation periods range from a minimum of 30 years here to 150 years overseas; free-growing stands, carrying only 50 trees per acre, necessitate the measurement of 0.2 acres (*i.e.* 10 trees) as the minimum unit of area. Taking these factors into account it will be realized why an acre per treatment . . . is now regarded here as the basic minimum size if border effects are to be largely eliminated."

"If the scope of thinning projects is to include a range of treatments, and if these are to be adequately replicated, then the acreage required for each project will, in most cases, far exceed the acreages of the uniform areas available. For this reason the advantages to be derived from replication are not regarded as sufficient compensation for the reduction in number of treatments, plot size and plot surround, which replication necessitates. . . . Research on thinning has, in the past, been conducted almost wholly within the zone of suppression. . . . Differences, due to treatment, have therefore been comparatively small. Under current research policy, thinning investigations include ranges of density between the extremes of no thinning (1,200 trees per acre) to free growth (50 trees per acre). . . . As the various treatments are correlated, it is anticipated that the resulting curve trends will also be correlated."

On one area, the only locality offering sufficient space, the proposed series will be replicated four times and "if, within the next decade, it is found that a statistical analysis . . . gives results which differ in any essential from those given by series which have not been replicated, the present technique will be discarded or modified so as to conform with standard statistical methods. . . . Framing the silvicultural policy cannot be postponed until it can be supported by precise data."

The above statements have been quoted at length as touching certain recent developments of experimental technique in the United States which have not been universally accepted as yet, as either necessary or practical.

The pronounced and demonstrated effect on diameter growth of early and heavy thinnings or sufficient growing space has led to the adoption of an initial planting spacing of 9 by 9 feet on good sites and 12 by 12 feet on sites of third quality. Thinnings are made on quality I sites at 8, 12, and 18 years; on quality II at 6, 14, and 25 years; and on quality III at 6, 20, and 30 years. These leave, respectively, 300, 200, and 130 trees on sites I and II and 180, 120, and 85 trees on site III. Yields 12,049, 9,905, and 4,535 cubic feet at 30, 40, and 50 years respectively are expected. The response to thinning is immediate and not gradual.

Pruning is a vital accessory to this thinning program. The removal of live branches from 25 percent of the living crown length had no measurable effect on increment. When 50 percent was removed, height and diameter growth were reduced, but for only one growing season. Even with 75 percent taken, the effect lasted but two seasons. If dead branches are allowed to remain and occlude, they give rise to loose knots. This is the basis for early pruning of the limbs while still alive, for this loose-knot zone between the tight-knotted core and the clear outer zone greatly depreciates the grades obtained.

It has also been found that planting does not require the former costly methods of soil preparation but is successful in the unbroken native low forest or "fynbos" (2 to 5 feet high), by using strong transplants. The expense is further diminished by the wide spacings advocated.

The limitation of space prevents the mention of many other valuable points covered by this bulletin, which is an outstanding example of the synthesis of research, economics, and management in a definite and well-rounded policy for

the federal conifer forest plantations of the Union of South Africa.

H. H. CHAPMAN,
Yale School of Forestry.

Fremdlaendische Wald- und Parkbaeume. (Exotic Forest and Park Trees.) By Carl Alwin Schenck. *3 vols. 615, 645, and 640 pp. Illus. Paul Parey, Berlin. 1939. RM 62 minus 25 percent, or about $18.*

This gigantic work covers the trees of the world outside of Germany. Not since Engler and Prantl's great classification of plant life and Heinrich Mayr's treatise on exotic trees has such an encyclopedic contribution been made in the field of dendrology. Mayr's book dates from 1906 and many changes have made it obsolete.

It is a matter of justifiable pride that the author of these mighty volumes is none other than Dr. Carl Alwin Schenck, German by birth but a pioneer American forester, some time director of the Biltmore Forest School, and now resident in Darmstadt. This fact explains the preponderance of American information and the loving care given to the treatment of American trees, in contradistinction to the somewhat cursory treatment of the trees of other countries. Dr. Schenck's heart is in America!

Dr. Schenck used to say, "The good United States is rich; it does not know how rich it is." Certainly, a perusal of these volumes, even a casual leafing of the pages and of the magnificent pictures (472 of them!) and maps, will convince the American forester that, in respect to tree kinds, we suffer from an "embarrass des richesses."

The first of these three superbly printed volumes starts with climatic sections, *i.e.*, 145 cross sections of United States, Canada, Newfoundland, Asia, and the countries of the Mediterranean. These are the countries of Origin. There follow 36 cross sections of the climate of the countries of Introduction, especially, of course, Germany. This part is exceedingly well done. Take, for example, Climatic Section No. 102—Central New York. Eight "stations" are tabulated, giving latitude and longitude, monthly mean temperatures and precipitation, and the average annual temperature and total precipitation. Explanatory notes, maxima and minima of temperatures, and a list of important tree species, complete this section.

After the Climatic Sections come the photographs, with names of the photographers. This pictorial display is a joy to see. It is far and away the finest display of tree and forest photographs known to the reviewer. Each photograph has a detailed caption and is referenced to the appropriate Climatic Sections. Outstanding are the photographs of the West Coast forests. Disappointing, however, are most of the Japanese pictures and particularly those of Siberia. If the Siberian pictures are typical of the forests there, then the U.S.S.R. is poor indeed (to paraphrase Dr. Schenck).

The second volume deals entirely with conifers and bears the title *Die Nadelhölzer.* It consists of a detailed alphabetical analysis of the genera and species. Under each species are notes covering synonyms; botanical description; varieties; occurrence (in native habitat and in Europe); silviculture (particularly the silvics of the species); protection; utilization, and suitability for planting in Europe.

The reviewer is delighted with the accuracy and wealth of detail in this volume. For example, under *Picea canadensis* or, as Schenck prefers to call it, *P. glauca,* he found absolutely authentic details as to the little known variety *albertiana* in eastern British Columbia. Thus on p. 247 it is correctly described as "descending the valley of the Fraser and occurring at Quesnel and . . . Kamloops." Such discerning accuracy is heartening; for, until lately, the spruce of eastern British Columbia was assumed by most foresters to be overwhelmingly Engelmann spruce. (Schenck cites an extensive reconnaissance survey near Quesnel, B. C. which lists 43 percent of the stand as *P. engelmanni* and does not mention *P. glauca.*)

The third volume of this dendrological trilogy deals exclusively with the broadleaved trees (*Die Laubhölzer*). It follows the same plan as in Volume 2 and with equally commendable results.

If every American forester acquaints himself with this valuable work; if all forestry school libraries include it; if the state and federal forest services make it available to their personnel, then and only then will Dr. Schenck's long labors be rewarded. For the language barrier is not an obstacle to making this book a useful tool in the better practice of American forestry and in broadening the appreciation of our intrinsic forest wealth.

Dr. Schenck could have done no greater service to American forestry than to write this book.

It challenges us to be worthy custodians of this great heritage: the trees of the "good United States."

A. B. RECKNAGEL,
Cornell University.

Sechrist's Foresters' Field Manual. By W. C. Sechrist. *128 pp. The Craft Press, Inc., Fayetteville, Pa. 1939. $1.50.*

"A ready-reference book of tables, data, and important information," this vest-pocket-sized manual should rapidly take the place of the pencilled notes which most field men carry on the backs of envelopes and on scattered loose sheets.

The many formulae and easily forgotten data necessary to the practicing forester are grouped under 14 chapter headings and are made more accessible with a thorough index. Doubtless this book, once in the possession of a field worker, will be consulted daily for usable information on mensuration, building materials, forest improvements, insects and insecticides, nursery work, explosives, paint, finance, water structures, and allied phases of applied forestry.

The manual is not intended to take the place of the many forestry and engineering texts and references which form the forester's library; its purpose is to answer questions which arise on the job and which must be answered at once. Salient points gleaned from numerous texts, manuals, and handbooks are grouped for the convenience of the user. For instance, the *Forest Truck Trail Handbook* and the *Improvement Handbook* of the U. S. Forest Service form the bases for a chapter on forest roads, trails, and bridges. Additional information, hints, and field short-cuts, however, give the user the benefit of the experience of the author and his associates.

Statements such as, "Knots should be shellaced after putting on primary coat—not before" and "Black Leaf 50 is ¼ stronger than Black Leaf 40," are typical of the author's concise presentation and efficient use of printed matter. Rules-of-thumb are given for the quick estimation of weights and strength of materials, areas of regular and irregular surfaces, load capacities of structures, mixes of concrete and mortar, and flow of water through weirs and pipe.

Among the many tables are those of weights and measures; board foot content of logs, squared timbers, and boards; conversion tables of various types; map scale ratios; and one entirely new table of weight per foot-length of green logs.

Bound in an attractive, bright red, leather cover, the manual is quite durable; and what is equally important, it cannot easily be mislaid. Varying amounts of white space left at the end of each chapter and a few blank pages in the back permit the addition of notes by the user.

A. G. HALL,
U. S. Forest Service.

The Forest Manager. By Dr. Karl Dannecker. *American edition, translated by Arthur O. Weidelich. 172 pp. Illus. American Forestry Association, Washington, D. C. 1939. $2.*

This book, appearing in the third or American edition, is a liberal translation from the German text, edited and adapted to American conditions. In the opinion of the reviewer, the American farmer, forest owner, and forester will find in this text many fundamental forest facts to aid him in the development and management of forest lands under his ownership or supervision.

The influences of the forest upon both life and living in the past, present, and future are stressed. Figures show the high economic value of the forests for the German people. Such facts and figures can easily be paralleled in any forested state in America. The value and importance of private forests in the national economy as well as the value of the forest as a farm enterprise are discussed. The author shows the importance of better management of the farmwoods as a supporting arm to agriculture.

Compared with the American, the German forest owner is limited in the number of commercially useful species of forest trees. Every kind of tree has definite requirements, the knowledge of which is essential for the forest manager. The author shows the importance of knowing the trees by types and individual species, their characteristics and behavior under different conditions of soil, moisture, elevation, and exposure, as well as when grown in pure stands or in combinations. He points out the necessity of adapting the species to both site condition and economic use.

In the chapter on "Forest Soil and Its Treatment" the author answers many questions which

arise in the mind of every forest owner, and especially the farmer, such as the importance of forest litter in relation to soil texture, fertility, and moisture, its relation to tree growth, the results from its removal for use in agriculture. It is the reviewer's opinion that if the information under this heading were known and applied by the American farmer, the management of our farm woodlands would be materially improved.

The forest stand and its treatment naturally follows as the next step in the management of a forest. The characteristics of a forest stand, whether managed or natural, the purpose and goals of stand treatment, methods of treating stands of various ages and conditions, and the final development of the timber stands are discussed as a basis for better management of a growing timber crop.

The author is a confirmed believer in the selection system in a forest harvest as the most natural method of forest management, as it provides for a more complete biological balance, provides conditions for a greater forest growth of better quality, with less damage from insects and diseases, and makes possible a more regular harvest, either annually or at shorter intervals than with other methods of management. Several variations of the selection method are outlined for different forest conditions. At least for certain species or combinations of species under German conditions the author develops a good case for selective cutting.

The chapter on "Harvesting, Preparation, and Utilization of Forest Products" goes into too much detail and many of the methods discussed are not applicable to American conditions.

Forest regulation and cooperative activities of forest owners are briefly discussed. During the past few years since the book was written there have been many changes in regulatory laws, many of which would not be of interest to American readers. Details of the German text were omitted. Many cooperative associations of forest owners were organized after the World War, but these have been disssolved and their functions assumed by the *Reichsnährstand*.

As a whole, this book deals with the fundamentals of forestry and the management of a forest in a practical, easily understood manner, and it should be of interest and value to many farmers and other forest owners. It, too, should be helpful to foresters dealing with American farm forest problems.

R. W. Graeber,
North Carolina State College.

Applied Silviculture in the United States. By R. H. Westveld. *567 pp. Illus. John Wiley & Sons, Inc. New York. 1939. $5.*

Originally placed on the market as a lithoprinted book, this treatise on silvicultural methods received the constructive suggestions of many teachers who used it as a text in schools of forestry. It is now printed as one of Wiley's regular forestry series.

Instead of dividing the United States into the conventional number of forest regions, the author uses eighteen, together with many types. The material under each region has been submitted to various authorities within the region for criticisms and additions. The staffs of the various regional forest experiment stations were particularly helpful in this.

Each region is treated from a statistical standpoint as to area, location, ownership, and production. The main physiographic and climatic features are discussed. What has happened to the forests in the past and how they are being logged at present form the backbone of the book. Slash disposal methods and insect and disease problems are brought to the reader's attention. Thus he is given a detailed picture of the forest composition and forestry practice requirements of the various regions.

The reviewer, having used the previous manuscript as a text, would have preferred to see a map of each region at the beginning of each chapter rather than as Figure 1. It is also to be regretted that certain minor errors that crept into the original copy were not corrected in the finished text. Many of the photographic reproductions are not as clear cut as could be desired.

In general this is an excellent textbook and deserves careful reading by both the student and the practitioner.

T. J. Starker,
Oregon State College.

CORRESPONDENCE

Dear Dr. Schmitz:

It is encouraging to get the reaction of Vincent W. Bousquet and John G. Miles in their article "As We See It" in the July issue of the Journal. They find themselves in an economic predicament affecting an ever-growing number of young men and women in every field of skilled, unskilled, and professional labor. Instead of resigning themselves to a situation of which they, like countless others, have been unwilling victims, they are attempting manfully to create their own opportunities to make an honest living.

In interpreting, however, the present lack of development of private forestry, the authors, rather than examine critically the factors responsible, have evidently accepted unquestionably the rationalizations of the apologists for the lack of progress in that field.

In the third paragraph, for instance, the authors explain why the business of forestry has not been made to yield dividends how and when desired. In this they may not have a full appreciation of the limitations peculiar to such enterprise. If quick returns on investments and quick conversion of timber capital are wanted, then obviously private forestry is not the answer. Forestry, whether private or public, must be understood to mean sustained yield—and, until the growing stock is adequately developed, deferred returns. Timberland owners who do not wish to recognize this vital principle are obviously not interested in practicing forestry. The authors themselves admit these points in citing examples of successful private enterprises in the South and West. Yet in concluding the fourth paragraph, they ask for the special privilege of assured quick cash returns even to those operators who are unwilling to accept the requirements of forestry enterprise. Perhaps they have in mind invoking some as yet undiscovered principle of genetics whereby timber on private lands can be financially matured in a fraction of the time now required; or do they contemplate some form of hand-out (perish the American thought)—a governmental insurance of cash returns?

The same confusion extends into the next paragraph: "We must somehow arrive at shorter rotations. . . ." Serious effort is now being made to meet the problems mentioned by public and private agencies established specifically for this purpose. Their solutions will not be obtained by any abracadabra, nor can they be found in the field of forestry alone. Taxation is a case in point. Investigations by the Forest Service have shown that the forest tax problem is so intimately tied up with taxation as a whole that it is impossible to settle the one without the other. One of the strongest criticisms of forest tax relief proposals is that they discriminate in favor of one type of

ownership, overlooking the fact that agricultural and many forms of industrial enterprises are also subject to delayed returns on invested capital.

As for "harassing . . . labor laws" would the authors deny the right of employees to organize and bargain collectively for decent wages and working conditions as clarified by the Wagner Act? Would they deny the payment to the head of a family of even the minimum rates of 25 cents an hour for 44 hours a week established by the Wages and Hour Law? Both these measures definitely recognize labor as an integral element of the social structure, not merely as an item in the cost of production to be cut whenever profits are not as high as the employer desires. The authors also overlook the fact that only as labor (comprising the mass of consumers) receives adequate compensation can the markets for forest products, and other products as well, be buil up and sustained. Furthermore, given the opportunity, labor can contribute to the success of industrial enterprises because it is rapidly coming to realize that only by helping industry to function more efficiently can it demand a larger share of the derived benefits.

The sixth paragraph would be clarified considerably if the authors explained what they meant by "a reasonable amount of cooperation." If they mean that the granting of subsidies will be based on the adoption of satisfactory standards of sustained yield, we agree. If, however, no such guarantees are implied, then we do not agree. The taxpayer has a right to insist that grants-in-aid be withheld unless and until standards are met. This should be taken to include conformance not only with forest practice rules, but also with federal labor laws.

We like the spirit displayed by the authors in the paragraphs near the bottom of page 518. This statement obviously represents their own deeprooted convictions to a greater extent, perhaps, than their previous remarks concerning the handicaps to private forestry. "We realize that society needs foresters . . . but we do not expect society to support us unless we can contribute something toward it." So also private forestry enterprise should not expect to be supported by society unless it too makes a contribution.

That is how we see it.

BERNARD FRANK AND
M. A. HUBERMAN.